Ministry of Energy
Ontario

Ontario Energy Review

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June 1979

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Minister
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ISBN 0-7743-4026-6

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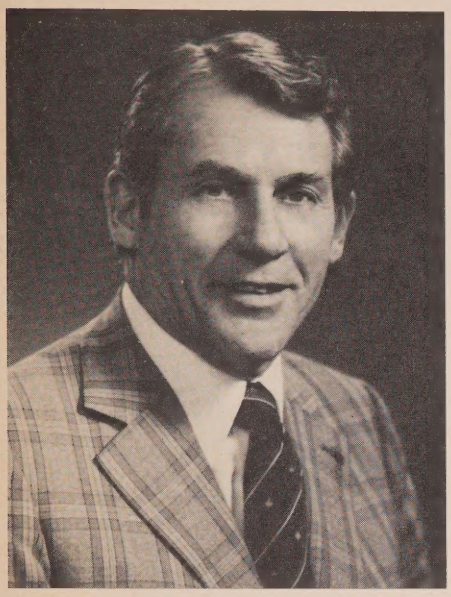
Ontario Energy Review
Foreword



I am pleased to introduce the Ontario Energy Review.

Designed to help the Ontario public and policy-makers become more familiar with the province's energy situation, this report aims not to discuss energy policy but to present as clearly and simply as possible the information guiding that policy.

A well-informed consumer can make more reasoned decisions about energy. I hope this publication will make a contribution to the general understanding of energy matters in Ontario.

Yours sincerely,

James A. C. Auld

James A. C. Auld
Minister of Energy

Contents

Units and Conversion Factors

In this publication imperial units are predominantly used since most readers will be more familiar with them. Conversion factors to the metric system are summarized below.

The following natural units and equivalent heat value conversion factors are used:

Imperial units

Energy form	Heat value
Petroleum (per barrel)	*Million BTU*
Crude oil	5.8030
Liquefied petroleum gases	4.0950
Motor gasoline	5.2220
Aviation gasoline	5.0505
Aviation turbo fuel	5.4145
Kerosene	5.6770
Diesel & light fuel oil	5.8275
Heavy fuel oil & still gas	6.2874
Petroleum coke	6.3852
Natural gas (per thousand cubic feet)	1.0000
Coal (per short ton)	
Anthracite	25.4000
Imported bituminous	25.8000
Canadian bituminous	25.2000
Sub-bituminous	17.0000
Lignite	13.2000
Coke (per short ton)	24.8000
Coke oven gas (per thousand cubic feet)	0.5000
Electricity (per megawatt hour)*	3.4120

*The conversion factor (10,000 BTU/Kilowatt hour) adopted for hydraulic, nuclear, and purchased electricity is the equivalent thermal energy, assuming efficiency of conversion is that of a coal-burning plant.

Metric units

Crude oil	1 barrel (at 60°F) = 0.158 91 cubic metres (m^3) (at 15°C)
Natural gas	1 thousand cubic feet (at 14.73 p.s.i.a. and 60°F) = 28.327 84 cubic metres (m^3) (at 101.235 kPa and 15°C)
Coal	1 short ton = 0.907 185 tonne (t)
Energy	1 BTU = 1.054 615 kilojoules (kJ)

Overview

Ontario imports about 80 per cent of its energy, primarily from other parts of Canada with some from abroad. The province is therefore extremely vulnerable to changes in energy supply and prices.

The uncertainties of world energy supply have recently been underlined by the crude oil production cuts due to the revolution in Iran. Fortunately, Canada is better placed than most developed countries to withstand world oil shortages because of its vast undeveloped reserves of fossil fuels.

Developing Canada's remaining fossil fuel reserves will be expensive, because they consist mainly of heavy oil deposits, oil sands, coal, and frontier oil and gas, requiring large, capital-intensive projects. But if Canada commits itself firmly to develop these reserves to the point of self-sufficiency, our national energy future can be assured. If promptly developed, these reserves could mean security of supply for years to come for Ontario, the industrial heart of the country. However, higher energy prices seem inevitable.

Ontario's population is expected to grow more slowly than it has in the past. Combined with higher energy prices and consumer conservation, slower growth could keep future energy requirements from being as great as historic trends would imply. Even so, as pointed out in the Ministry of Energy's 1977 publication *Ontario's Energy Future*, over the next fifty years Ontario will have to reduce its reliance on non-renewable crude oil and natural gas and turn increasingly to energy from renewable resources.

This Review is in two parts. The first part, Energy Update, outlines recent trends in the supply and consumption of each type of energy used in Ontario. It examines the province's energy production and distribution networks. It looks next at changes in energy prices and then examines provincial initiatives in developing forms of renewable energy and in implementing conservation programs.

The second part, Energy Outlook, presents three different views of how Ontario's energy needs may change over the next twenty years as well as the likely sources of energy supply.

With this Review, therefore, the essential facts of the province's energy situation are summarized for the public.

The first section of the Energy Update outlines the major energy types currently in use in the provinces and shows where they come from. After that, the various sources of supply and the recent trends in consumption are considered in turn for each basic energy type.

For crude oil and its derivatives, the importance to Ontario of prompt development of the western Canadian oil sands and frontier oil reserves is shown, as a protection against a likely world shortfall in supply and against extreme price increases.

With natural gas, again, the importance to Ontario of protecting future Canadian self-sufficiency can be seen.

With coal, although Canada is recognized to have vast reserves, the cost of transportation to Ontario continues to be a formidable problem.

The limits to future development of Ontario's hydroelectric sources are in sight, but the rapid growth of nuclear technology has reduced the need for increased reliance on coal for thermal electricity generation.

The next part of the Energy Update summarizes recent energy price increases, showing Ontario to be fairly fortunate compared to other jurisdictions.

From there the Review considers the progress of Ontario's strong commitment to the development of renewable energy, widely regarded as important to the province's long-term energy future.

Finally, the importance of provincial energy conservation programs is discussed and illustrated.

How Ontario's energy picture may change from now to the year 2000 is examined in the Energy Outlook section. Based on a number of assumptions, three possible energy consumption patterns are projected for the province, and the prospects of adequate supply are explored.

In summary, the finding of the Energy Outlook is that Ontario should be able to avoid an energy crisis during the next twenty years, barring curtailment of crude oil exports by the producing countries and provided that Canadian oil sands, heavy oil, and frontier energy sources are expeditiously developed.

Ontario's energy comes in several different forms. Most people, if asked to name them, would probably mention electricity, oil, and natural gas; a few would remember coal. To make the matter clear, however, it must be remembered that electricity is not a primary energy source like the others. It is a secondary energy source generated in Ontario mainly from water-power, coal, and uranium, and to a lesser extent from oil and natural gas. This distinction enables us to complete the picture of Ontario's primary energy sources (Figure 1). Crude oil meets 41 per cent of Ontario's primary energy needs. Natural gas meets 22 per cent. Coal (14 per cent), water-power (13 per cent), and uranium (10 per cent) provide the rest.

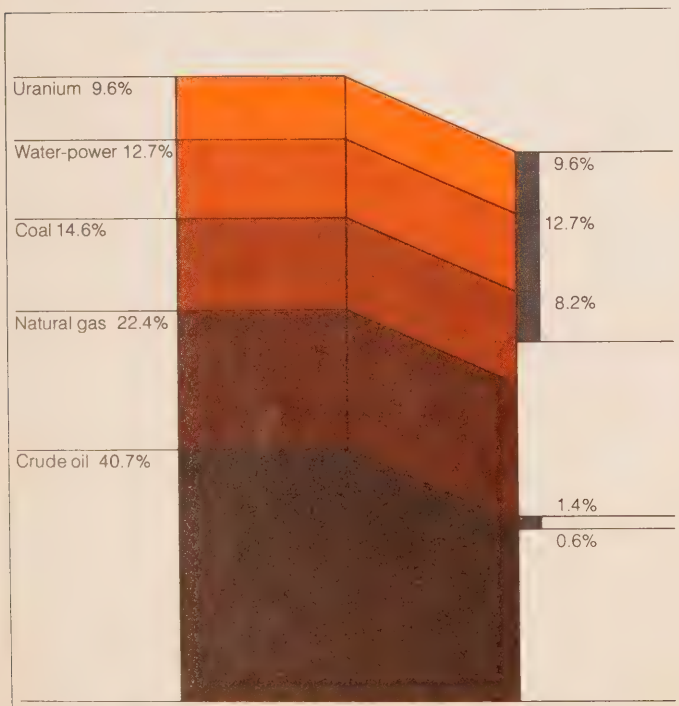
The energy picture for Canada as a whole looks rather different from Ontario's (Figure 2). Crude oil use is about the same as for Ontario and meets 44 per cent of Canada's needs; natural gas meets 18 per cent, and coal 9 per cent. But hydraulic sources meet 25 per cent of Canada's needs, over twice as much as in Ontario, while uranium sources meet less than one-third as much as they do in Ontario.

Ontario itself produces only about 20 per cent of the energy it consumes, mainly in the form of electricity, primarily from water-power and uranium. Only very small amounts of oil and natural gas are produced in this province. The bulk of Ontario's energy is imported, and of these imports more than three-quarters come from other provinces, chiefly Alberta (Figure 3). Nine-tenths of Ontario's oil and virtually all its natural gas come from elsewhere in Canada. About 20 per cent of Ontario's energy supply is imported from the United States, comprising some oil and much of the coal used in the province. Ontario also exports some energy, mainly electricity and heavy fuel oil to the United States, equivalent to about 7 per cent of the province's energy requirements.

Figure 4 sets out the complex energy trade pattern between Ontario, the rest of Canada, and the United States.

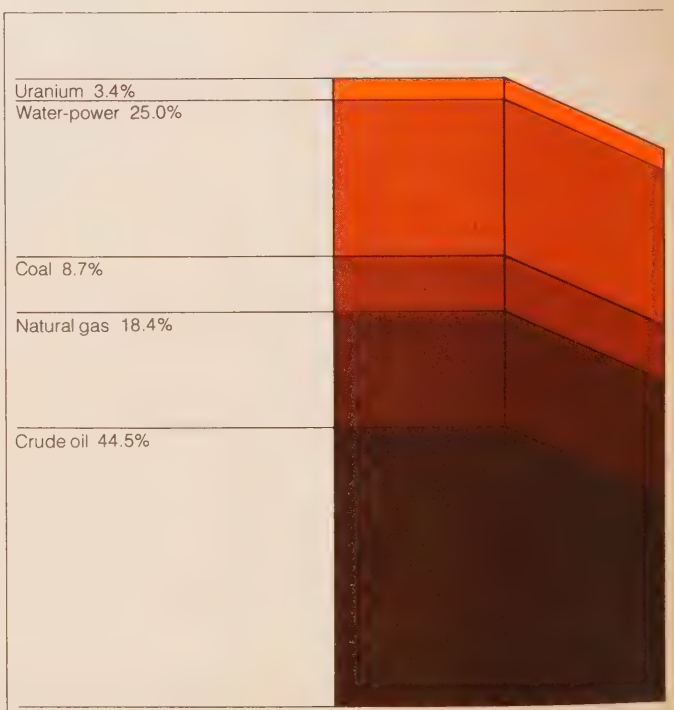
With this general picture in mind, we turn now to consider past trends in supply and consumption of each type of energy. We shall then be able to review with some understanding the recent energy price changes. After that we shall examine provincial initiatives towards using untapped renewable energy sources and reducing energy waste through conservation programs.

FIGURE 1: Ontario's primary energy consumption 1978



Total consumption: 3075 x 10^{12} BTU (530 million barrels of oil equivalent)
■ Total primary energy for electricity generation: 32.5%

FIGURE 2: Canada's primary energy consumption 1978



Total consumption: 8600 x 10^{12} BTU (1480 million barrels of oil equivalent)

FIGURE 3: Ontario's primary energy sources 1978

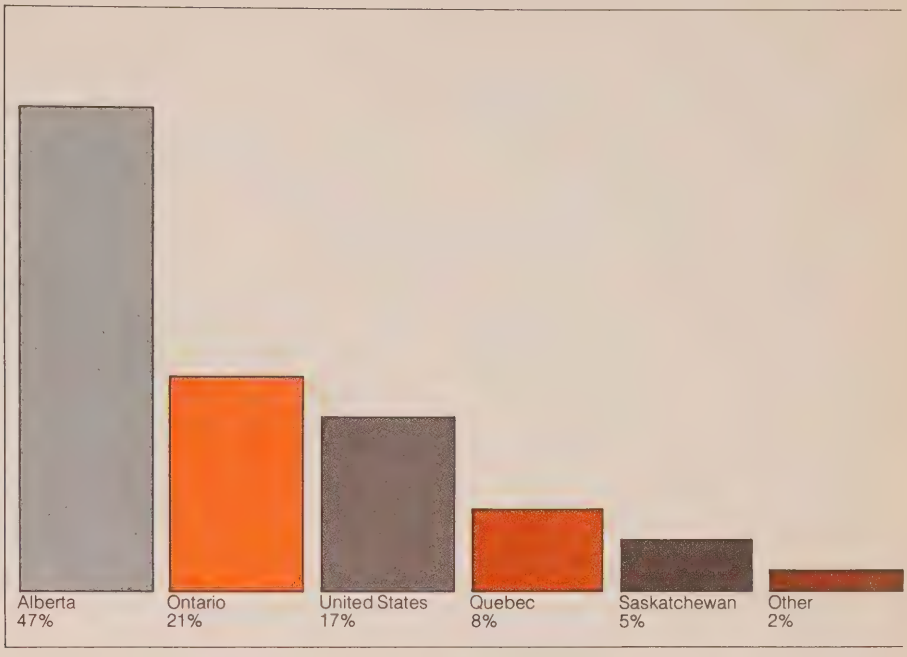


FIGURE 4: Energy flows to and from Ontario

When the Organization of Petroleum Exporting Countries (OPEC) launched the first massive increase in crude oil prices in 1973, the world's energy picture was transformed. It is not hard to see why: OPEC members produce half the world's oil (Figure 5). In 1978, world oil production was about 62 million barrels a day (bd), with OPEC countries contributing nearly 30 million bd. North America produces a little over 20 per cent of the world's crude oil, mostly in the United States (10.2 million bd); a great deal of the remaining one-third of world oil is produced in the USSR (11.5 million bd).

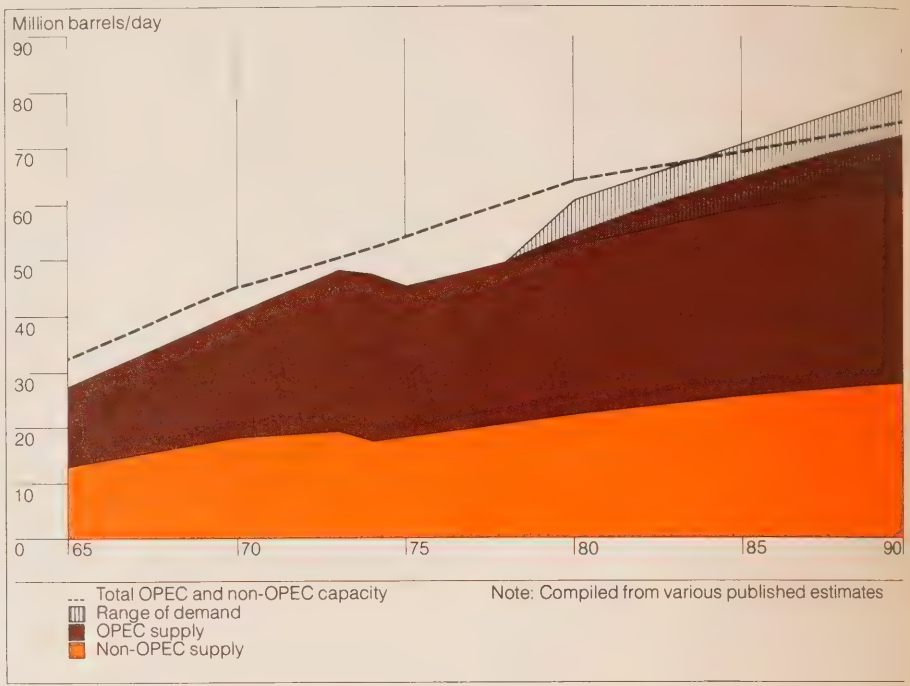
Partly as a result of the OPEC pricing decisions, the world's demand for crude oil has begun to slow its rate of increase. Conservation programs, substitution of other fuels for oil, and slower economic growth generally in the developed countries have helped restrain the demand for crude oil. The development of new oil fields has rushed ahead as an alternative to OPEC; by mid-1978, the Alaska North Slope was producing 1.2 million bd, the North Sea 1.5 million bd, and Mexico 1.2 million bd. However, these new oil finds, though important, are not large enough to change significantly the long-term supply picture. In the short term, the world's oil-producing *capacity* is currently greater than actual production by about 10 million bd, or nearly 18 per cent. Virtually all of that surplus capacity, however, is in OPEC countries.

This surplus capacity may not last long. Some experts project that at current rates of consumption every oil field will be in full production as early as the mid-1980s (Figure 6). By that time not enough crude oil may be available to meet demand, and as a result oil prices could rise sharply, affecting consumption. The question will then be how long world oil reserves will last.

Of the world's proven crude oil reserve of about 640 billion barrels, Saudi Arabia alone holds nearly one-quarter (Figure 7). Altogether, the OPEC countries, including Saudi Arabia, hold about two-thirds of world oil reserves.

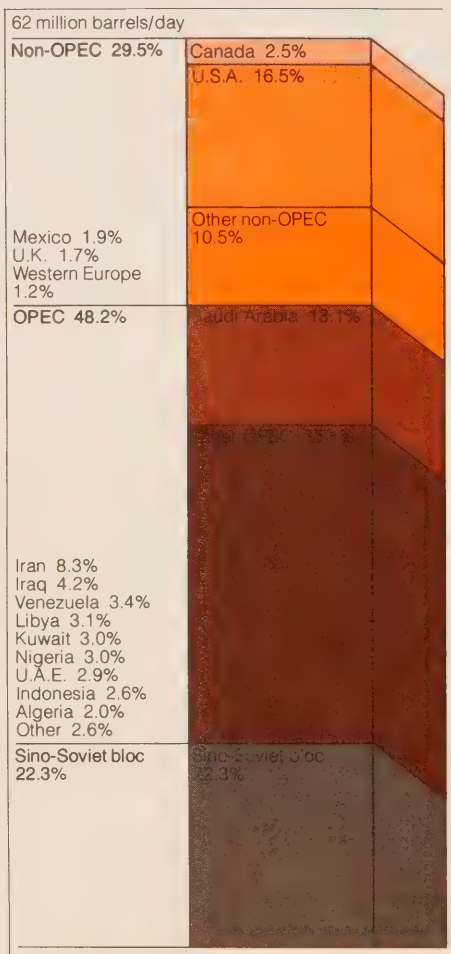
By comparison, the United States, with 29 per cent of world oil consumption and importing 43 per cent of its requirements, holds about 4.4 per cent of world oil reserves; the North Sea holds 4 per cent, Mexico 2 to 4 per cent, and Canada (excluding the oil sands) 1 per cent. Obviously OPEC's control of the world's oil supply is not about to decline.

FIGURE 6: Crude oil supply and demand outlook for the non-communist world



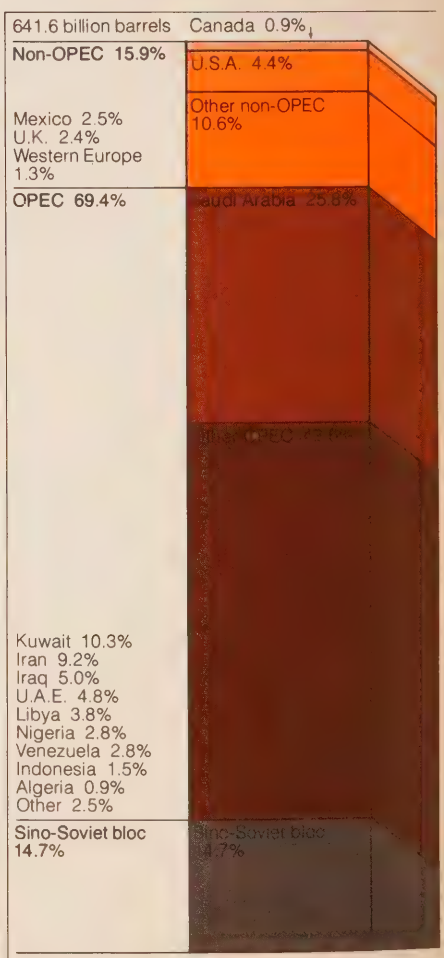
Note: Compiled from various published estimates

FIGURE 5: World crude oil production 1978



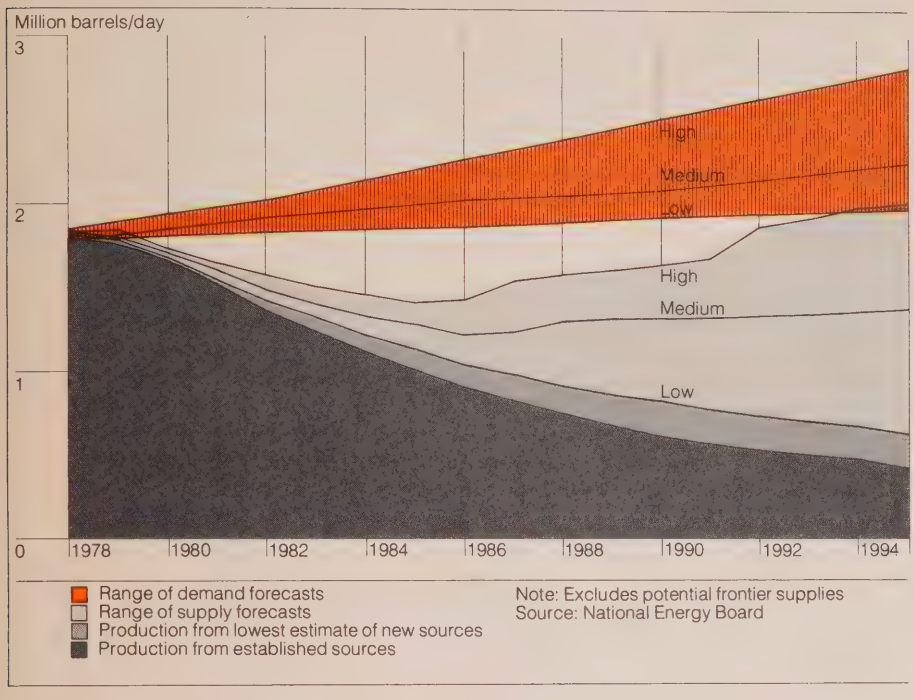
Source: Oil and Energy Trends

FIGURE 7: World crude oil reserves as estimated at 1 January 1979



Source: Oil and Gas Journal
Note: Oil sands and shale oil reserves excluded

FIGURE 8: Canadian oil supply and demand outlook



Canadian Crude Oil

Canada is not self-sufficient in oil. In 1978 Canada produced about 1.5 million barrels a day of crude oil and equivalent and consumed about 1.8 million bd. Canadian production includes synthetic crude oil from oil sands, which by year-end had reached a level of about 100,000 bd. Canada imported 620,000 bd of crude oil but also exported about 260,000 bd to the United States, so that net imports were 360,000 bd, about 20 per cent of the country's requirements.

In its September 1978 report the National Energy Board estimated Canada's established remaining recoverable reserves of conventional crude oil as of 1 January 1978 at 5.8 billion barrels. It also reported that there is sufficient domestic oil to supply the area west of the Ottawa Valley, which includes most of Ontario, until at least 1995, the last year of its forecast. However, for Canada as a whole the NEB projected an increasing net oil deficit.

Figure 8 shows three different forecasts of Canadian oil supply and demand prepared by the NEB. Demand is projected to be between 2 and 3 million barrels a day by 1995, but domestic supply is expected to dip sharply in the early 1980s and then either continue to decline to 0.7 million bd or partially recover to as high as 2 million bd, mainly through development of oil sands plants. The medium forecasts suggest that, unless domestic production is increased beyond current expectations, oil imports will have to increase to around 1 million bd by 1995 to meet demand.

During the late 1980s and early 1990s, the major portion of additional Canadian crude oil supplies will most likely be obtained from development of the oil sands. Supplies from frontier sources – the Arctic, the Mackenzie Delta, the Beaufort Sea, and off Canada's east coast – are not expected before 1995.

Canada has the potential to be self-sufficient in crude oil. Besides proven conventional oil reserves of 5.8 billion barrels, it is estimated that 26 billion barrels of synthetic crude oil can be recovered from the oil sands by surface mining and a further 170 billion barrels by 'in-situ' methods. But oil sands and frontier sources are relatively expensive and will require significant investment, while the technology for the recovery of in-situ reserves is not yet proven.

Oil Sands Development

Two oil sands plants are now producing commercially in western Canada. The first commercial-scale synthetic crude oil plant was the Great Canadian Oil Sands installation at Fort McMurray in northern Alberta, which came on stream in 1967 and is now producing about 45,000 barrels a day. On 1 August 1978 the Syncrude project announced that its first synthetic crude oil had been piped to Edmonton. The plant is expected to achieve full licensed capacity of 129,400 bd by 1983. In February 1975 the Ontario government, through the Ontario Energy Corporation, took a 5 per cent financial interest in the project to help ensure its completion. In December 1978 Ontario sold its interest to PanCanadian Petroleum Ltd of Calgary.

Further oil sands development is planned. Syncrude is considering expanding the capacity of its plant to 190,000 bd. Great Canadian Oil Sands has received approval to increase capacity to 58,000 bd by 1984. Somewhat further into the future – in the late 1980s – a Shell Canada consortium plans to have an oil sands plant in operation with a capacity of 140,000 bd at a cost of around $4.9 billion. Imperial Oil's proposed 140,000 bd plant at Cold Lake is expected to cost around $4.7 billion. A number of heavy oil upgrading plants are also receiving consideration, but their status is still indefinite.

Oil in Ontario

Ontario accounts for 30 per cent of total Canadian oil consumption. Yet only a tiny amount (less than one-half of 1 per cent of Ontario's consumption) is provided from Ontario's own production, which in 1978 was 1600 bd. About 88 per cent of Ontario's crude oil supply comes from western Canada through the Interprovincial Pipeline (Figure 9). Most of the rest is supplied from United States crude oil exchanged for equal quantities of western Canadian crude oil delivered to refineries in the United States. No imports of crude oil from outside North America were received in Ontario during the past year, although parts of eastern Ontario are supplied with refined petroleum products produced in part from foreign crude oil refined in Montreal.

FIGURE 9: Major oil pipelines and oil fields in Canada

FIGURE 10: Ontario's oil pipeline system

Refineries in Ontario

The Ontario refineries that convert the crude oil to petroleum products are located in three areas (Figure 10). Over half the province's refinery capacity is at Sarnia, with the remainder located in the Oakville-Clarkson-Port Credit area west of Toronto and at Nanticoke on Lake Erie. The principal products of Ontario refineries are shown in Figure 11. In 1978 gasoline accounted for only one-third of refinery production, down from 1970. The shares of heavy fuel oil, mainly for industrial use, and of petrochemical feedstocks, which are used to produce plastics, nylon, and so on, have grown. Refined products then move by truck, train, lake tanker, and pipeline throughout the province (Figure 10).

Ontario's refinery capacity has increased from 414,000 bd in 1973 to 816,000 bd in 1978 (Figure 12). At present Ontario has about one-third more refinery capacity than is required to meet the demand for oil products. Even so, because of transportation costs, some 14 per cent of Ontario's consumption of refined petroleum products was imported during 1978, primarily from Montreal refineries into nearby eastern Ontario. Ontario refineries produced 540,000 bd, equivalent to 90 per cent of total Ontario consumption, but of this some was exported or sold in other provinces.

Ontario's surplus refinery capacity has led to severe price competition between oil companies, especially in certain gasoline markets in Ontario. While the public has benefited from this price competition, oil companies have experienced relatively low rates of return on refining and marketing operations.

A by-product of the refining process is residual heavy fuel oil. As with gasoline the surplus refinery capacity has led to severe competition between refiners and with natural gas in the industrial market.

FIGURE 11: Ontario refinery production

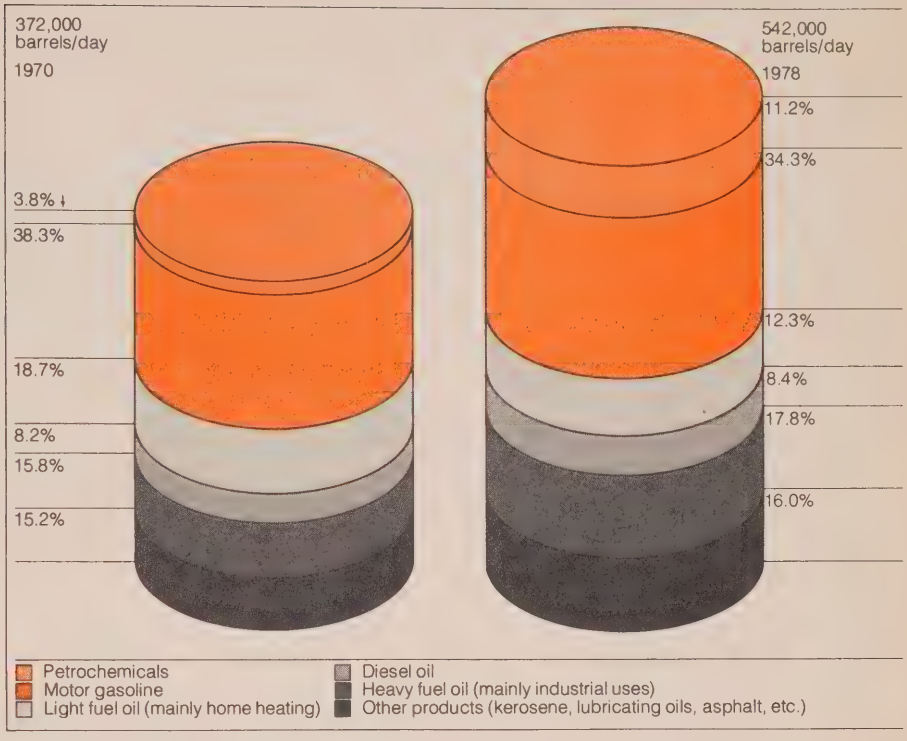


FIGURE 12: Ontario's crude oil refining capacity 1978

	Barrels/ calendar day
Petrosar (Sarnia)	170,000
Imperial (Sarnia)	130,000
Texaco (Nanticoke)	95,000
Sunoco (Sarnia)	90,000
BP (Oakville)	80,000
Shell (Corunna)	80,000
Gulf (Clarkson)	79,000
Texaco (Port Credit)	48,000
Shell (Oakville)	44,000
Total	816,000

Note: Texaco's Port Credit refinery is currently cut back pending a decision on future operations.

Consumption

Recent trends in the consumption of oil products in Ontario are presented in Figure 13. This figure, like others that follow, shows the end use of energy products in the Residential, Commercial, Industrial, and Transportation markets. Over half (55 per cent) of Ontario's oil consumption is used in Transportation. Residential, or household, uses consume 17 per cent; Industrial uses, including mining and manufacturing, consume 12 per cent. The Commercial sector (for example institutions, office buildings, schools, street lighting, and water works) uses only 4 per cent of the province's oil. The remainder is accounted for by consumption of petrochemical feedstocks, asphalt, lubricating oils, and other non-energy products, as well as oil use by the refineries themselves.

Following the price increases beginning in 1973 the consumption of oil products fell off in 1975, but it has since increased. In 1978 the increase in consumption was in the order of 4 per cent over the previous year. Since 1970, consumption for Transportation and for non-energy products has been growing steadily. However, the combined requirements of the Industrial, Commercial, and Residential sectors have declined.

FIGURE 13: Oil consumption in Ontario

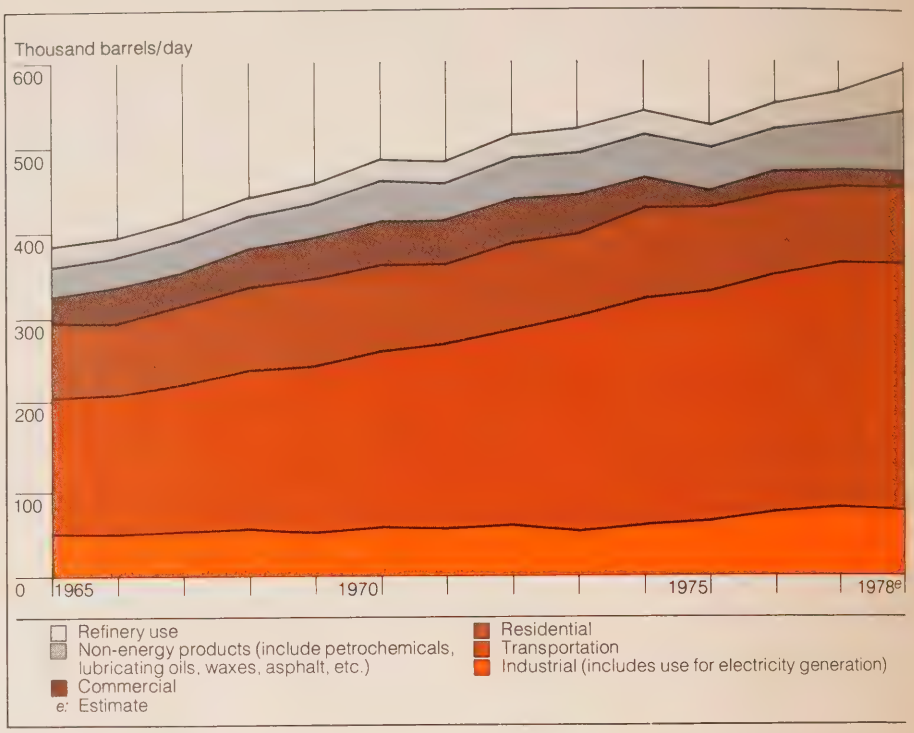


FIGURE 14: Major natural gas pipelines and fields in Canada

Natural Gas

World natural gas production as a source of supply for Ontario is of no importance at the present time because Canadian gas supplies are adequate to the country's needs. Natural gas reserves in Canada are located mainly in Alberta, with smaller but significant quantities situated in British Columbia and Saskatchewan (Figure 14).

Significant reserves have been found in the arctic islands and in the Mackenzie Delta/Beaufort Sea area, and there are prospects off the east coast of Canada. These reserves cannot be counted on unless enough additional quantities are found to make their development and shipment to market worthwhile.

The National Energy Board's latest estimates of the ultimate potential of marketable natural gas in the conventional areas of Canada are as follows: British Columbia 18Tcf (trillion cubic feet), Alberta 125 Tcf, Saskatchewan 3 Tcf, and other provinces 1 Tcf. About 67 per cent of this total has been found to date, and 22 per cent has been produced.

Total Canadian production of marketable natural gas in 1978 was about 2.5 Tcf, of which 1.5 Tcf was used in Canada and about 1 Tcf exported to the United States.

Just as important as the extent of reserves is the deliverability of the natural gas – the rate at which the gas could be produced with the current state of technology. Since the production volume of every well sooner or later begins to decline, new reserves must be found if the amount of gas being delivered is to grow or even remain constant.

From 1970 to 1975 the amount of reserves found in Canada each year was less than that being produced. This led to serious concern about the ability of reserves to meet future demand. Since 1975 prices have increased, the demand has been less than forecast, and the addition of new reserves has exceeded production, so that there is more natural gas in Canada available for sale than the domestic market can currently absorb.

The National Energy Board held extensive hearings in late 1978 on Canada's present and future gas supply and requirements. Its report, released at the end of February 1979, estimates that Canada can meet its own gas demand and authorized exports at least until the 1990s (Figure 15). This report has set the stage for a series of hearings on market expansion in Quebec and the Maritime provinces and on gas exports to the United States.

FIGURE 15: Canadian natural gas supply/demand outlook

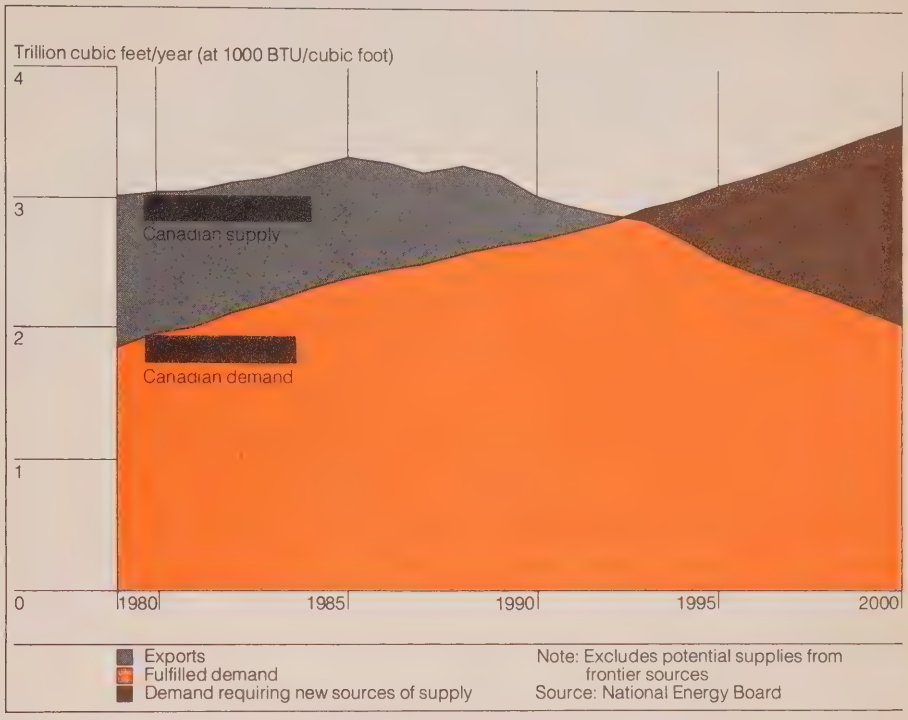
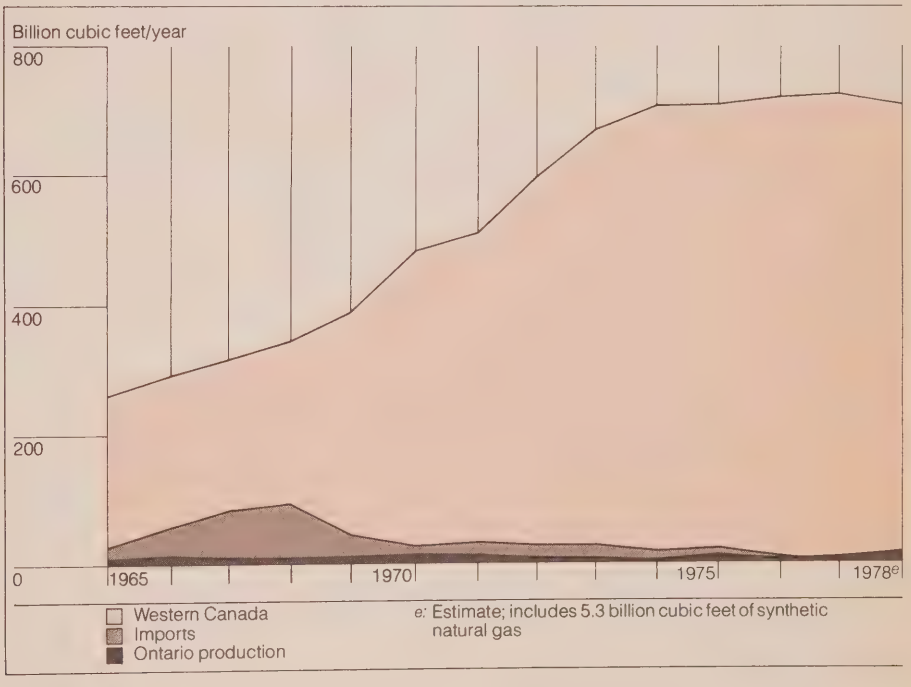


FIGURE 16: Natural gas supply in Ontario



Ontario's Sources of Supply

Most of Ontario's natural gas is supplied from western Canada (Figure 16). Ontario's domestic production of gas accounts for only about 1 per cent of Ontario's supply. Imports of natural gas from the United States, which reached a peak of about 23 per cent of total supply in 1968, no longer occur.

Virtually all Ontario's gas currently comes from Alberta wells. It is delivered from Alberta by TransCanada PipeLines Ltd over two pipelines, one branch of which goes through northern Ontario and the other proceeds south of the Great Lakes.

Some of the gas is piped to underground storage pools in southwestern Ontario. With new pools added in 1978 the province's total storage capacity has now reached 138 billion cubic feet (Bcf), about two months' supply. Not only does this storage capability provide security of supply in emergencies but it also allows distributors to purchase gas at a constant flow, meet winter peak demands, and minimize transportation costs.

Natural gas is distributed in Ontario primarily by three companies: Consumers' Gas Company, the largest, covering much of central and eastern Ontario, Union Gas Ltd, covering southwestern Ontario, and Northern and Central Gas Corporation Ltd (Figure 17).

Ontario's Consumption

Ontario uses three times as much natural gas now as it did in 1965. As Figure 18 shows, the province's gas consumption grew rapidly from 219 billion cubic feet in that year to 650 Bcf in 1974. Since then it has grown only slightly and has perhaps even begun to decline a little.

Natural gas is not used for transportation. Industrial uses (55 per cent currently) predominate, their share having risen from 48 per cent in 1965. The Industrial sector includes the natural gas used to generate electricity. The Commercial sector's share has risen from 17 to 24 per cent, while the Residential sector's share has declined from 36 to 21 per cent. In both Residential and Commercial sectors, average per customer use has recently been declining, partly as a result of conservation efforts motivated by higher prices.

The economic downturn and competition from heavy fuel oil have limited expansion of natural gas in the Industrial sector. Ontario Hydro has recently reduced its demand for natural gas from 49 Bcf to less than 20 Bcf in 1979 and estimates it will consume only about 10 Bcf a year by 1980.

Ontario's Production

Efforts are being made to increase Ontario's natural gas production. They are focused on Lake Erie, where two-thirds of Ontario's gas is produced. In 1977 a total of 187 oil and gas wells were drilled in Ontario, of which fifty-four were for exploration and 114 for development of proven reserves. This activity, together with the continuing exploration program, should result in total 1978 Ontario domestic production of about 11.5 Bcf (up from 8.5 Bcf in 1977), with 7 to 7.5 Bcf of that coming from Lake Erie. This amounts to about 1 per cent of Ontario's requirements.

'Synthetic Natural Gas' (SNG), which is a by-product of the Petrosar refinery in Sarnia, started to be produced in late 1977. The volume of SNG being produced will rise to about 9 Bcf a year, or nearly as much as is coming from Ontario wells. Its cost, however, is currently almost twice as much as that of western Natural gas delivered to Toronto.

New Transportation Systems

There is general agreement that by the 1990s the supplies of gas in the Mackenzie Delta/Beaufort Sea area, in the Arctic islands, and possibly in other frontier areas may be required to meet Canadian demand. Because of the long lead times needed to plan, finance, and construct frontier pipeline or liquefied natural gas (LNG) facilities, several major proposals are under active consideration; these have been included in Figure 14.

At the present time all estimates of the ultimate reserve potential in the frontier regions of Canada must be regarded as highly speculative. The Geological Survey of Canada regularly analyses the available data and makes estimates based on different levels of probability. In its latest review (EP 77-1) the Geological Survey estimates that there is a 50 per cent probability of the ultimate potential in the Mackenzie Delta/Beaufort Sea area exceeding 60 Tcf. It also estimates a 50 per cent probability that the reserves in the Arctic islands will exceed 50 Tcf and those in the east coast offshore area will exceed 40 Tcf.

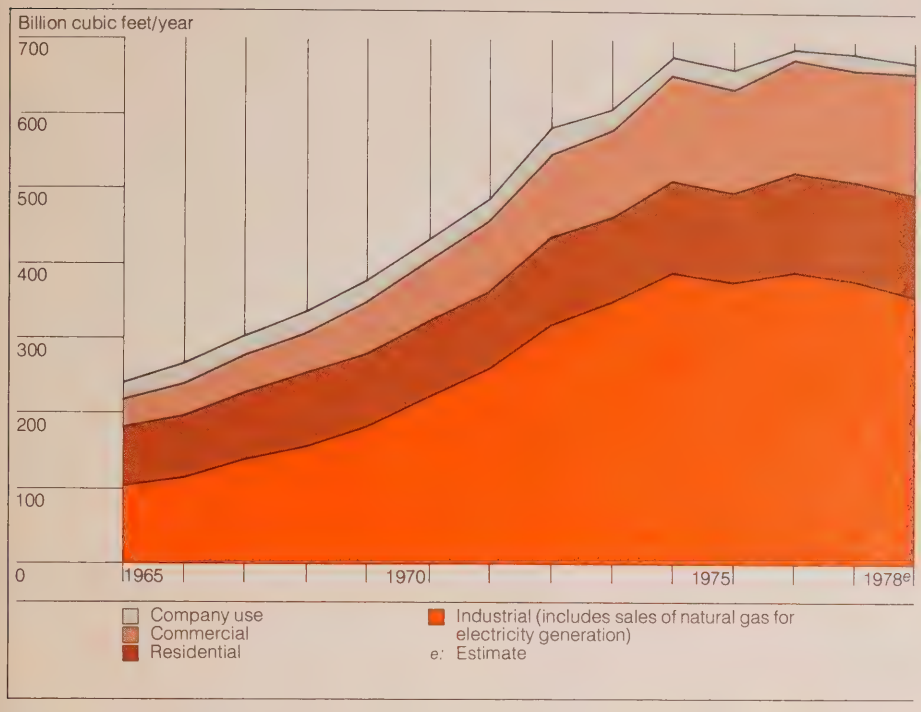
Planning is well underway for the Alaska Highway Pipeline, which has obtained Canadian and U.S. Government approval. Designed to deliver gas from Prudhoe Bay, Alaska, to American markets, it could later connect Canadian gas reserves in the Mackenzie Delta and Beaufort Sea to the existing distribution systems in Canada. However, major hurdles have still to be overcome before this project becomes a reality; gas sales contracts and financing plans have yet to be arranged.

Foothills Pipelines Ltd, the Canadian sponsor of the Alaska Highway Pipeline proposal, plans to apply to the National Energy Board to build the Dempster Highway Pipeline, which would link the Mackenzie Delta reserves to the Alaska Highway Pipeline at Whitehorse. The Dempster Highway Pipeline, if built, would be 737 miles long and would transport about 1 billion cubic feet a day of natural gas.

Polar Gas, a joint venture in which the Ontario Energy Corporation is a participant, has applied to build a pipeline from Melville Island in the eastern Arctic to connect with the TransCanada PipeLine system in northern Ontario. The pipeline would be 2338 miles long and would transport over 2 Bcf a day. This line would tap the Arctic island reserves and would be a direct line to Ontario.

Polar Gas also recently announced that it is studying the feasibility of the Y-line option, a combined system to deliver both Mackenzie Delta reserves and Arctic island reserves via a pipeline crossing northern Canada to connect with the TransCanada PipeLine system in northern Ontario.

FIGURE 18: Natural gas consumption in Ontario



Two applications to extend the Canadian natural gas transmission pipeline system beyond Montreal are currently before the National Energy Board. TransCanada PipeLines has proposed to extend its system from Montreal along the north shore to Quebec City and to build a second extension south of Montreal to carry gas to the Eastern Townships. Q & M (Quebec and Maritime) Pipelines Ltd has proposed to build a new line from Montreal along the north shore to Quebec City, then across the St Lawrence to serve New Brunswick and Nova Scotia. The National Energy Board will be scheduling hearings into these proposals later in 1979.

Two studies are underway concerning the transportation of liquefied natural gas to eastern Canadian markets from the high Arctic. A PetroCan-Alberta Gas Trunk Line proposal would ship LNG from Melville Island to the east coast, while Dome Petroleum and TransCanada PipeLines are studying the possibility of LNG transportation from King Christian Island to a terminal near Quebec City. PetroCan-Alberta Gas Trunk Line have filed their application with the National Energy Board.

FIGURE 17: Natural gas pipelines in Ontario

Canada is estimated to have, south of the 60th parallel, more than 76 billion tonnes (metric tons) of coal resources potentially available as an energy source competitive with the present price of crude oil. In 1978, Canada produced a total of 30.5 million tonnes of all types of coal, of which about 13.7 million tonnes was exported. About 14.1 million tonnes was imported in 1978, and in effect Canada's production and consumption are approximately in balance. More than 60 per cent of Canada's coal consumption is used in generating electricity, another 23 per cent in the steel industry, and the remainder mainly in other industrial uses.

Ontario's Supply

Ontario currently produces no coal and must rely instead on imports. In 1978, for instance, about nine-tenths of the coal supplied to Ontario came from the United States and the remainder from western Canada and the Maritimes (Figure 19). From 55 to 60 per cent of the coal consumed in Ontario is used to generate electricity. Although it costs about 30 per cent more, Ontario Hydro is now purchasing western Canadian coal primarily in order to diversify its supply sources and also to obtain the low-sulphur grades, some of which are blended with American coal. Ontario Hydro has contracted for 3.7 million tonnes a year of western Canadian coal between 1980 and 1995, about one-quarter of its annual requirements.

Deliveries from western Canada were initiated in 1978 using the new Thunder Bay coal terminal, officially opened in September 1978. Designed to move 5.4 million tonnes annually, with an initial annual throughput of 2.7 million tonnes and a stockpile capability of 1.1 million tonnes, the terminal serves to link western rail transportation with Great Lakes vessels and acts as a surge point to absorb seasonal variations. It is the cornerstone of the transportation system being developed to move western Canadian coal to Ontario.

The other significant use for coal in Ontario is as coke for making steel. Ontario and Canada's three largest steel-makers, Stelco, Dofasco, and Algoma, import almost all their coking coal from the United States. Of an estimated import volume of 6.4 million tonnes, Stelco accounts for half. In addition, that company has signed a five-year contract for 500,000 tonnes a year of metallurgical coal from Nova Scotia's Lingan mine. Dofasco is reported to be investigating several coal properties in western and eastern Canada in order to secure additional supplies.

FIGURE 19: Coal supply in Ontario

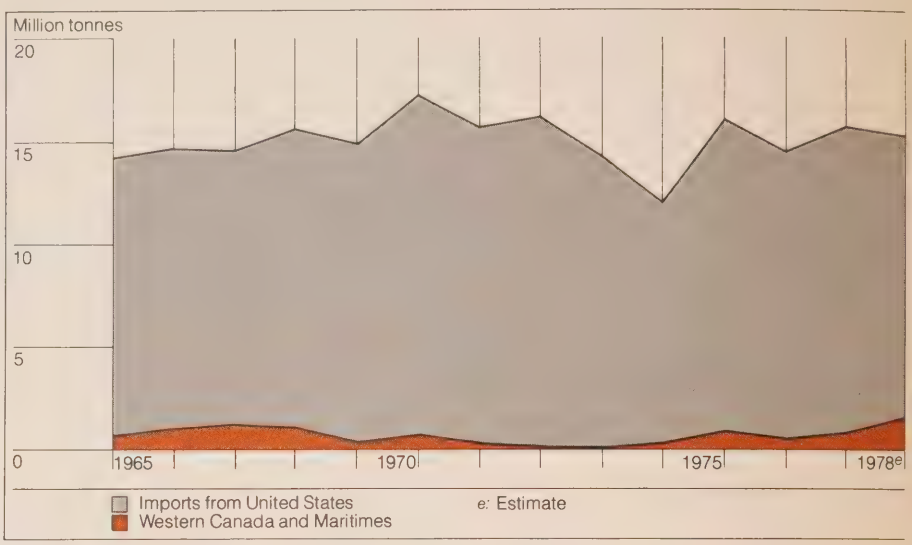
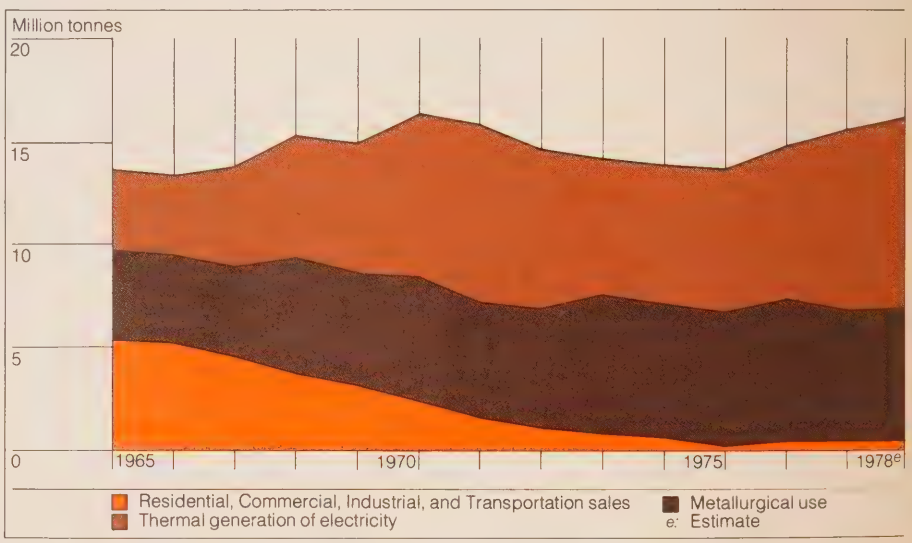


FIGURE 20: Coal consumption in Ontario



Interest has recently been revived in the lignite coal deposit at Onakawana in the James Bay area. The 190 million tonnes of lignite there are suitable for industrial purposes or for an electrical generating station located at the mine.

The government has recently announced that the James Bay Lowlands area north of Timmins will also be reopened to mineral exploration.

Ontario's Consumption

Coal consumption in Ontario peaked in 1970 at about 16.5 million tonnes. As Figure 20 shows, coal is now seldom used directly as a source of heat. The Residential, Commercial, Industrial, and Transportation sectors combined consume only about 3 per cent of the coal used in Ontario, down markedly from their 39 per cent share in 1965.

Metallurgical coal consumption has increased, and its share of total consumption has risen from 32 per cent in 1965 to 38 per cent today. However, for a variety of reasons Ontario's steel-makers have entered a period of slower growth which is being reflected in a lower growth rate in their coal requirements.

The use of coal in generating electricity has doubled since 1965, increasing its share of total consumption from 29 per cent to nearly 60 per cent now.

Water-power

Water-power continues to be an important, although in relative terms declining, primary energy source for the generation of electricity in Ontario. Currently the province has 6289 megawatts of dependable hydroelectric capacity, which contributes an average annual output of 4710 megawatts.

Undeveloped hydroelectric resources in Ontario total a further 4300 megawatts in average annual output. The major potential – 2750 megawatts – lies in northerly flowing rivers, namely the Severn and the Albany (including the Winisk – Attawapiskat system). The cost of developing these northern rivers is not precisely known but is believed to be high because of the difficult terrain and remote location. No development of the Albany River system is currently contemplated, pending completion of the reports of the Royal Commission on the Northern Environment and of the Royal Commission on Electric Power Planning. Over half of the rest of the undeveloped potential – 800 megawatts – is made up of many small sites that would have an average annual output of less than ten megawatts each.

A program for the expansion of hydroelectric generation, including ten new developments and seven extensions or redevelopments of present stations, was announced by Ontario Hydro in August 1978. If all necessary approvals are obtained, construction on the seventeen projects could begin as early as 1982 and could be completed by 1994. The actual timing of this program, however, is likely to depend on the future demand for electricity and the resulting need for additional generating resources. The peak capacity of this part of the hydraulic program, if fully implemented, is roughly 2000 megawatts, with an average annual output of more than 500 megawatts.

Uranium

Canada possesses approximately one-fifth of the western world's estimated uranium resources and is expected to play an important role in meeting the world's projected uranium requirements. To safeguard Canadian interests, the federal government's uranium policy requires enough uranium to be reserved for domestic use to enable each existing and planned Canadian reactor to operate at an average annual capacity of 80 per cent for thirty years from its in-service date.

Early in 1978 it was estimated that at prices of up to $160 a kilogram Canada had uranium reserves of 507,000 tonnes, composed of 82,000 tonnes measured, 107,000 tonnes indicated, and 318,000 tonnes inferred. As the resource estimates in the latter two categories are less reliable than in the measured category, they are adjusted by weighting factors in order to arrive at an 'adjusted reserve' against which domestic requirements can be compared. On this basis, the Canadian adjusted reserve is calculated as being 390,200 tonnes.

Long-term uranium requirements for Ontario Hydro's existing and planned reactors amount to just over 20 per cent of Canada's total adjusted reserve. Beyond their existing commitments and their required domestic allocations, Canadian uranium producers therefore still have almost half of the adjusted reserve available for future export or domestic needs.

During the past year major uranium discoveries not included in the reserves mentioned above have been announced at Midwest Lake and at Key Lake, Saskatchewan. These finds will of course greatly enhance the long-term security of uranium supply in Canada.

Virtually all the uranium consumed in Ontario comes from within the province itself. With the commissioning of the Pickering nuclear station, Ontario's consumption of uranium has risen to nearly 500 tonnes in 1978. In February 1978 the Ontario government approved the purchase by Ontario Hydro of nearly 91,000 tonnes of uranium from the Elliot Lake area for a period beginning in 1980 and extending to 2020. One contract, with Denison Mines Ltd, calls for the delivery of 57,000 tonnes between 1980 and 2011, and the other, with Preston Mines Ltd, is for 33,000 tonnes between 1984 and 2020. These contracts protect Ontario Hydro's existing and planned nuclear program in case the anticipated worldwide demand for nuclear energy results in uranium shortages in the late 1980s or early 1990s. Moreover, Hydro is expected to obtain these supplies at prices lower than world prices over the long term.

Electricity

Electricity is a secondary energy source manufactured from the primary energy sources: coal, water-power, uranium, oil, and natural gas. Figure 21 shows that the primary energy composition of Ontario electricity has been changing dramatically over the last decade or more. Since 1965 Ontario's electrical energy supply has more than doubled. In that time, however, the output of Ontario's traditionally predominant source of electricity, water-power (hence 'hydraulic' or 'hydro' electricity), has remained relatively constant, so that the rivers and dams that provided 63 per cent of Ontario's electrical power in 1965 now account for only 34 per cent of the total.

In 1965 less than one-quarter of Ontario's electricity was thermally generated, using coal, oil, or natural gas. By 1978 this conventional thermal output had more than tripled, so that coal (with small additional amounts from gas and oil) produces about one-third of the province's electrical power.

But the most important recent development is the onset of nuclear-powered (uranium) thermal generation in the 1970s; uranium-based electricity has increased rapidly in

FIGURE 21: Electricity supply in Ontario

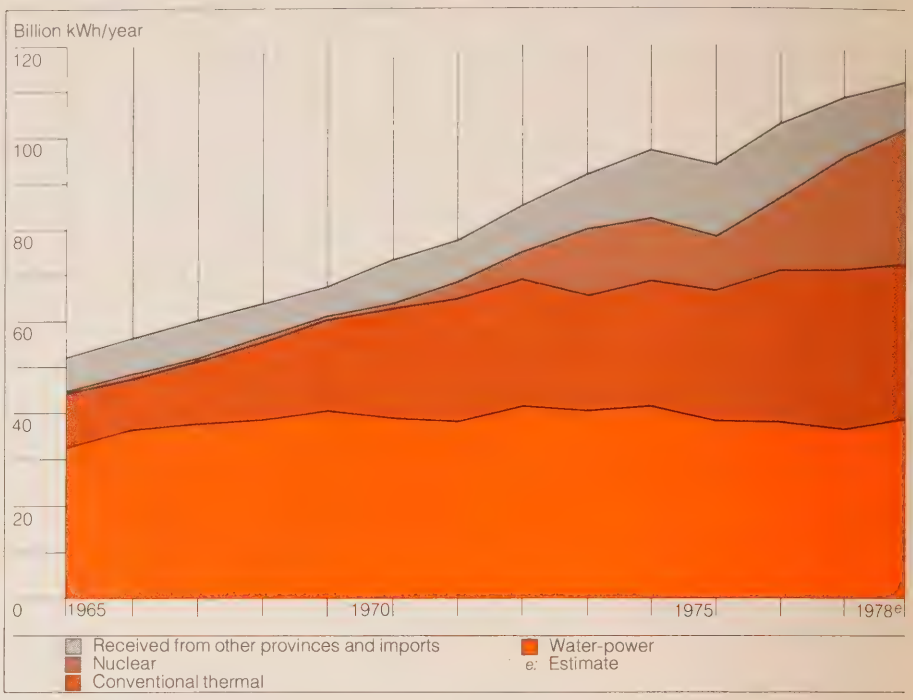


FIGURE 22: Ontario Hydro generating capacity, April 1979

	Dependable Capacity Megawatts	Proportion of System	Planned Capacity Megawatts	Proportion of Expanded System
Hydraulic Generating Stations				
East System (Rivers: Niagara, Welland Canal, St Lawrence, Ottawa, Madawaska, Abitibi, Mississagi, Mattagami, Montreal, etc.)	5,710		Program to add 2,000 MW under development	
West System (Rivers: Nipigon, English, Kaministikwia, Winnipeg, Aquasabon, etc.)	579			
Total Hydraulic Generation	6,289	26.5%		18.9%
Nuclear Generating Stations				
Douglas Point (AECL)	206			
Bruce (Kincardine)	2,960		3,076	
Darlington (Newcastle)	—		3,400	
Nuclear Power Demonstration (Rolphton)	22			
Pickering	2,056		2,064	
Total Nuclear Generation	5,244	22.1%	8,540	41.5%
Conventional Thermal Generating Stations				
Atikokan (Phase I)			400	
J. Clarke Keith (Windsor)	being rehabilitated		256	
Richard L. Hearn (Toronto)	1,104			
Lakeview (Mississauga)	2,298			
Lambton (Courtright)	2,100			
Lennox (Kingston)	2,172			
Combustion Turbines	445			
Nanticoke	3,920			
Thunder Bay	97		310	
Combustion Turbines and Diesel Electric	29			
Wesleyville (Port Hope)	—		construction stopped	
Total Thermal Generation	12,165	51.4%	966	39.6%
Grand Total	23,698		9,506	

Note: The dependable capacities reported are the 20-minute peaks for the month of December

FIGURE 23: Ontario Hydro System

the last few years until in 1978 about 26 per cent of the province's electrical supply was produced by that means.

A final component of Ontario's electrical supply is imports from Quebec, Manitoba, and the United States; these imports have remained relatively constant in absolute terms since 1965 but have declined as a percentage from 15 to 10. At the same time Ontario's electrical exports have grown until in 1978 they exceeded imports.

Today, water-power, coal, and uranium each contribute to the production of about one-third of Ontario's electricity. This means that about two-thirds of the province's electricity is produced from Ontario-based resources: water-power and uranium.

Ontario Hydro generates almost all the electricity produced in Ontario, although there are a number of small privately owned generating utilities operating commercially in the province.

The generating capacity of Ontario Hydro's system is described in Figure 22, and the generating stations and transmission lines are shown in Figure 23. Nuclear generation has provided a new and rapidly growing source of efficient and steady base-load supply, whereas some of the hydraulic and most of the conventional thermal generating capacity are better suited to handle peak loads, which can be significant both daily and seasonally. Since the limits of feasible hydraulic generation are now in sight, this type of electrical generation will have a diminishing share of provincial electricity output.

In April 1979, Ontario Hydro announced a new schedule of in-service dates for its approved generating stations. The new schedule anticipates that the two units of the Thunder Bay station will come into service in 1980 and 1981; the four units of Pickering B between 1981 and 1983; the four units of Bruce B between 1983 and 1987; the two units of Atikokan in 1984 and 1988; and the four units of Darlington between 1987 and 1990. Construction on the station at Wesleyville will be stopped and the equipment stored until the 1990s.

Ontario Hydro distributes electricity in two ways (Figure 24). About 60 per cent of its production is sold wholesale to the province's more than 300 municipal utilities, which in turn service nearly two million urban retail customers. The remaining 40 per cent is sold direct by Ontario Hydro, the greater part wholesale to more than one hundred heavy industries and the rest retailed to more than three-quarters of a million 'rural' customers not served by the municipal electrical utilities.

The electrical supply picture has been transformed since 1965, but the pattern of consumption has scarcely changed at all (Figure 25); consumption has simply doubled in all sectors. Commercial and Industrial uses still consume about two-thirds, and Residential and Farm uses remain just over one-quarter.

Historically the demand for electricity in Ontario has grown at about 7 per cent annually. In the past few years this growth has diminished. Ontario Hydro's 1979 load forecast released in February 1979 predicted an average growth in the peak demand of 4.7 per cent annually to 1990 and 4.2 per cent from 1990 to the turn of the century.

Nuclear Power

There are four operating nuclear generating stations in Ontario: at Pickering, at Bruce and Douglas Point in the Bruce Nuclear Development, and at the Nuclear Demonstration Project near Rolphton northwest of Ottawa (Figure 22).

In 1978, Pickering 'A' units ranked second, fourth, eighth, and twelfth in performance among over ninety reactors in the world whose capacity exceeds 500 megawatts. The station as a whole operated at a net capacity factor of 87.8 per cent during 1978. Pickering's total unit energy cost was 10.1 mills per kilowatt hour in 1978, which compares to a 13.7 mills per kilowatt hour fuelling cost alone for producing electricity under similar conditions from Ontario Hydro's most efficient coal-fired plant, Lambton Generating Station near Sarnia.

Bruce 'A' Unit 3 was declared in service on 1 February 1978. In 1978 the three Bruce reactors operated at an average of slightly less than three-quarters capacity. The fourth and final unit was declared commercially in service on 18 January 1979, marking the completion of the 2960 megawatt station, one of the world's largest.

Electrical production from Ontario Hydro's nuclear units displaced 8.8 million tonnes of coal in 1978; cumulatively to date nuclear production has displaced about 49 million tonnes of coal.

FIGURE 24: Ontario Hydro sales

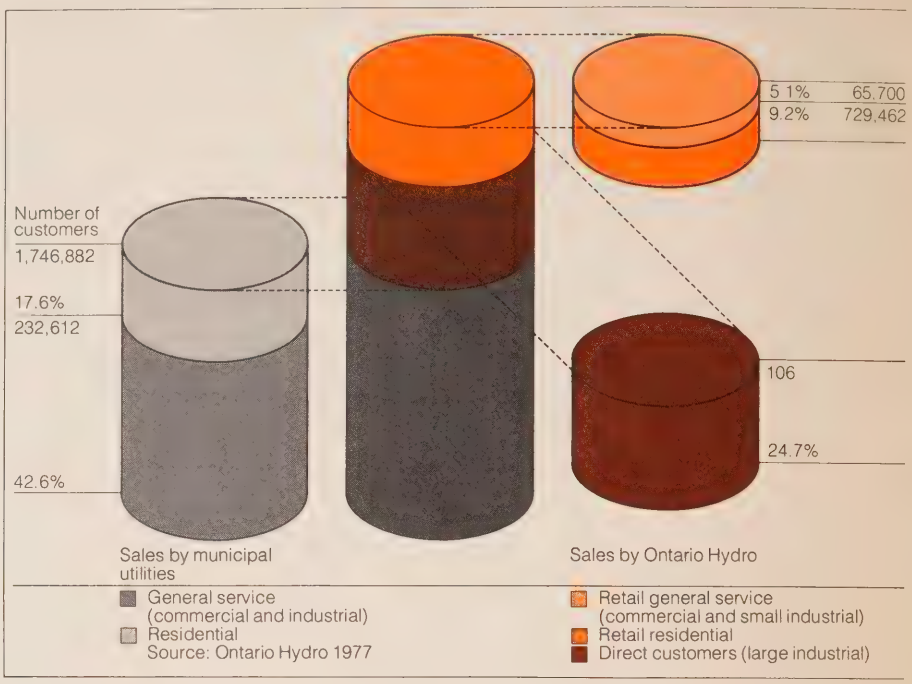
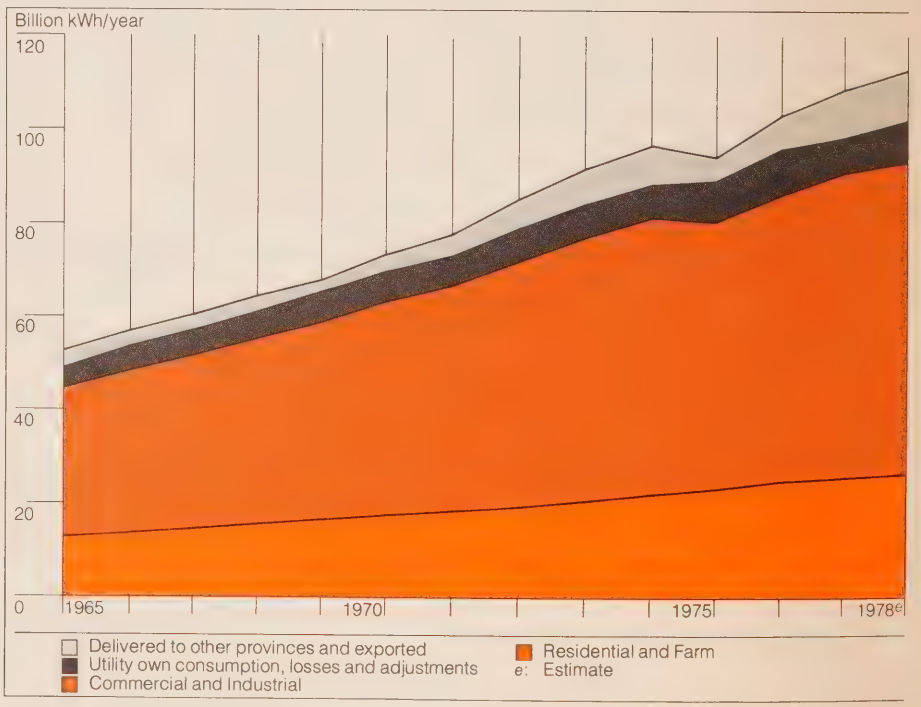


FIGURE 25: Ontario electricity consumption



Energy Prices

Since 1973 the wholesale price of energy in Ontario has increased sharply and in some cases has more than tripled. At the retail level fuel prices have not increased as dramatically as that, because processing and distribution costs have not risen as sharply and, in the case of gasoline, because of intense competition in certain Ontario markets.

The picture seen by the Ontario consumer is suggested in Figure 26, in which the Toronto Consumer Price Index (CPI) is compared with indexes for the costs of residential heating oil, natural gas, electricity, and gasoline and for personal disposable incomes since 1965. Through the 1960s the energy price indexes lagged behind the CPI; natural gas prices in fact did not change at all until 1973. That was also the year the heating oil index clearly passed the CPI.

Not until 1975 did the gasoline index exceed that of the CPI, and for natural gas and electricity not until 1976. By 1978, though, the picture had changed. Estimates show the CPI to have reached 206; gasoline was nearest that at 218; then electricity at 224; while heating oil had soared to 336. Instead of holding back the over-all price increase, energy is now driving it forward. Like the CPI, however, energy prices have not climbed as rapidly as incomes.

Figure 26 shows only proportional increases, not the prices themselves. Figure 27 compares wholesale energy prices in Ontario since 1965 based on the cost of each by the amount of heat energy it represents.

FIGURE 26: CPI and energy indexes

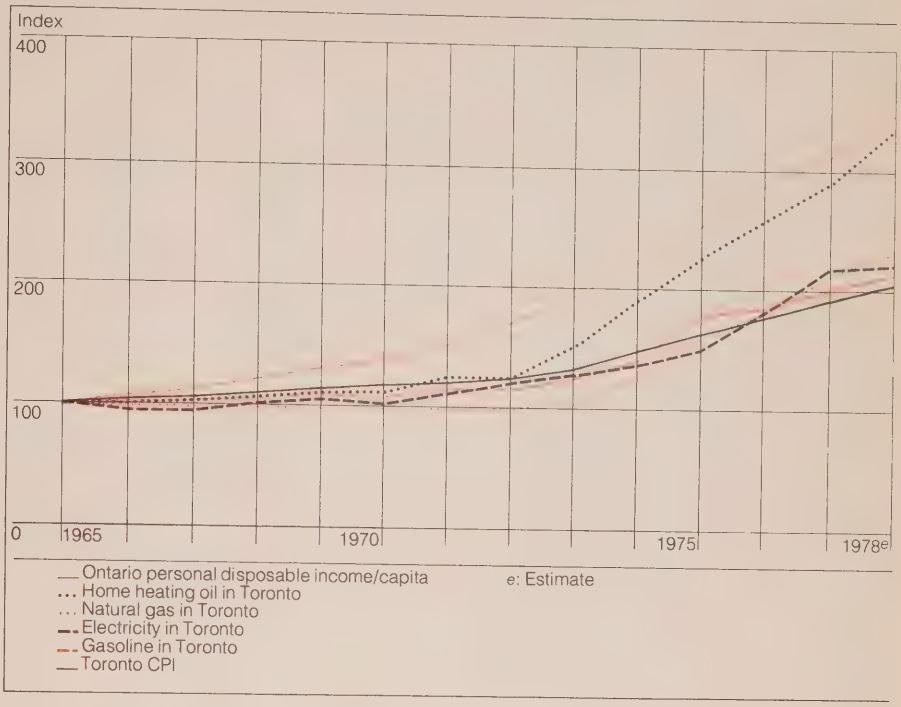
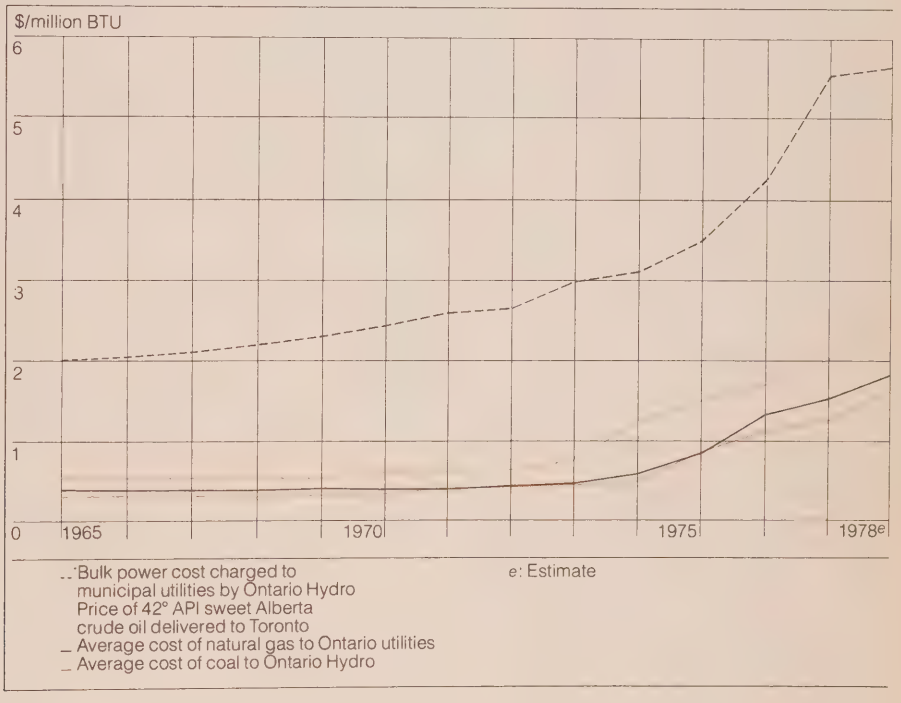


FIGURE 27: Wholesale energy prices in Ontario

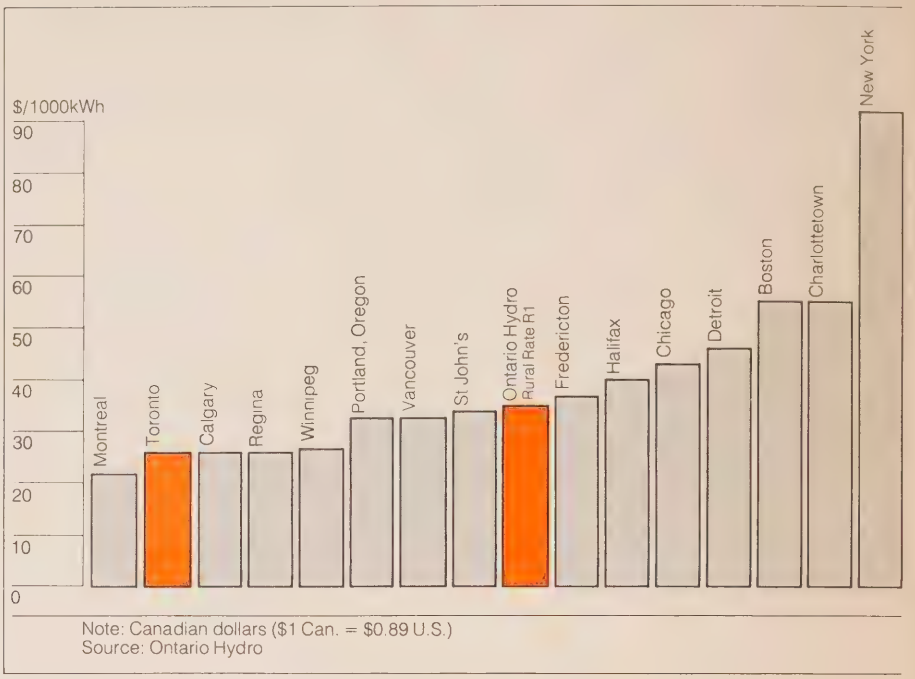


Two points are obvious. First, for oil the increase came suddenly in 1974 (a year later for coal and natural gas), whereas for electricity the increases were more gradual, starting in the 1960s. Moreover, since 1973 the prices of oil, natural gas, and coal have more than tripled, whereas electricity prices have approximately doubled.

Secondly, electricity is much more expensive than the other three forms of energy. Its greater cost reflects the fact that it is a secondary form of energy, itself created from primary forms. In many applications, however, its use is more efficient, which tends to narrow the price differences.

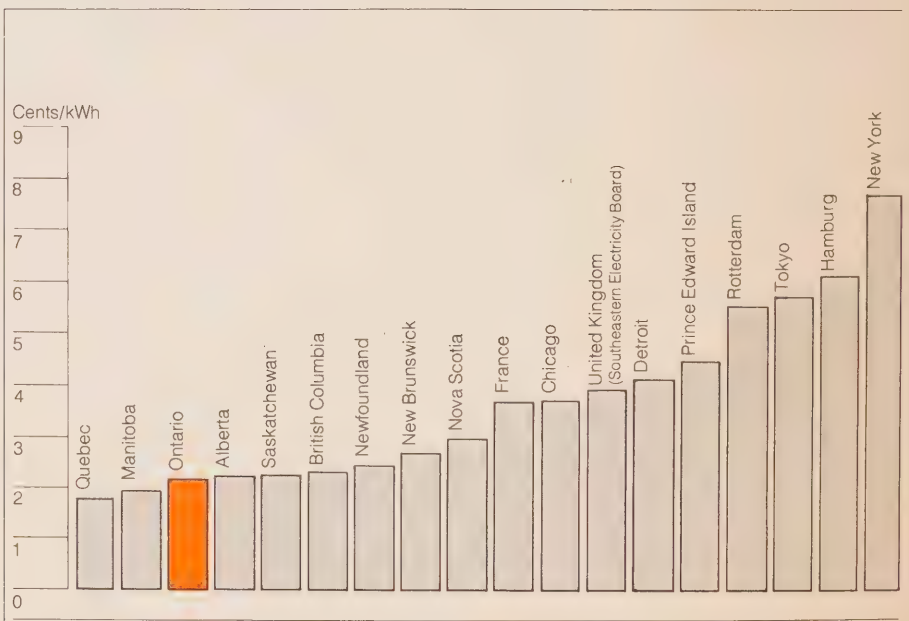
Not all parts of Canada and the United States have been affected equally by rising energy prices. For instance, Ontario communities pay less for electricity than most other North American cities (Figure 28). And when it comes to industrial electricity rates, Ontario is one of the more fortunate provinces, with rates much lower than in most other industrialized parts of the world (Figure 29).

FIGURE 28: Residential electrical bills – July 1978



Note: Canadian dollars ($1 Can. = $0.89 U.S.)
Source: Ontario Hydro

FIGURE 29: Industrial electricity rates – March 1978



Source: National Utility Service, Inc.
Note: Canadian dollars ($1 Can. = $0.89 U.S.)
Customer size 1000 kW/450,000 kWh

Where does the consumer's energy dollar go? One example is the case of gasoline in Figure 30, which shows that in Toronto one-third goes to government in the form of taxes. The cost of crude oil accounts for 42 per cent, and the remainder pays for refining and marketing costs, including dealers' margins, which are less than 10 per cent.

Focusing on the cost of crude oil and natural gas in Alberta, Figure 31 shows that more than half is now taken by Alberta and the federal government as royalties and taxes, while 44 per cent goes to the oil companies.

The estimates for 1978 assume the producer reinvests in exploration and development two-thirds of his net revenues after paying operating costs.

FIGURE 30: Gasoline cost at the pump

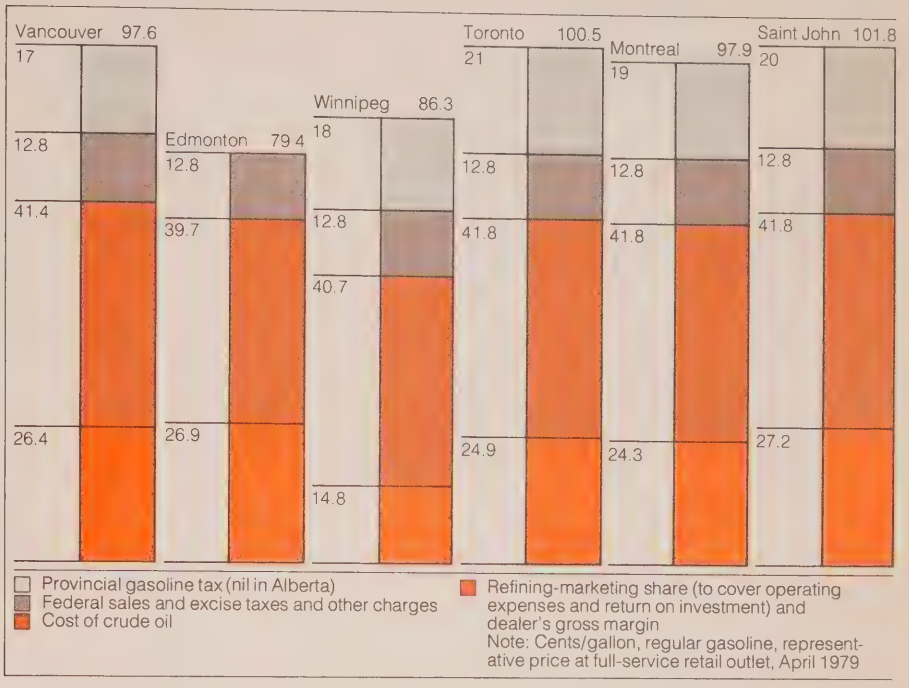
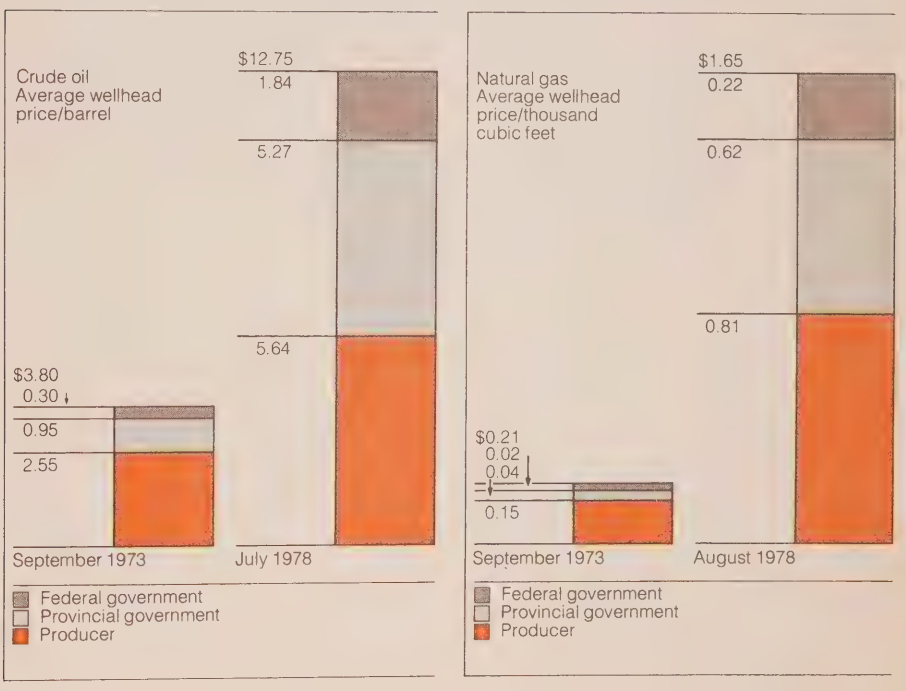


FIGURE 31: Sharing of revenues from oil and gas production in Alberta



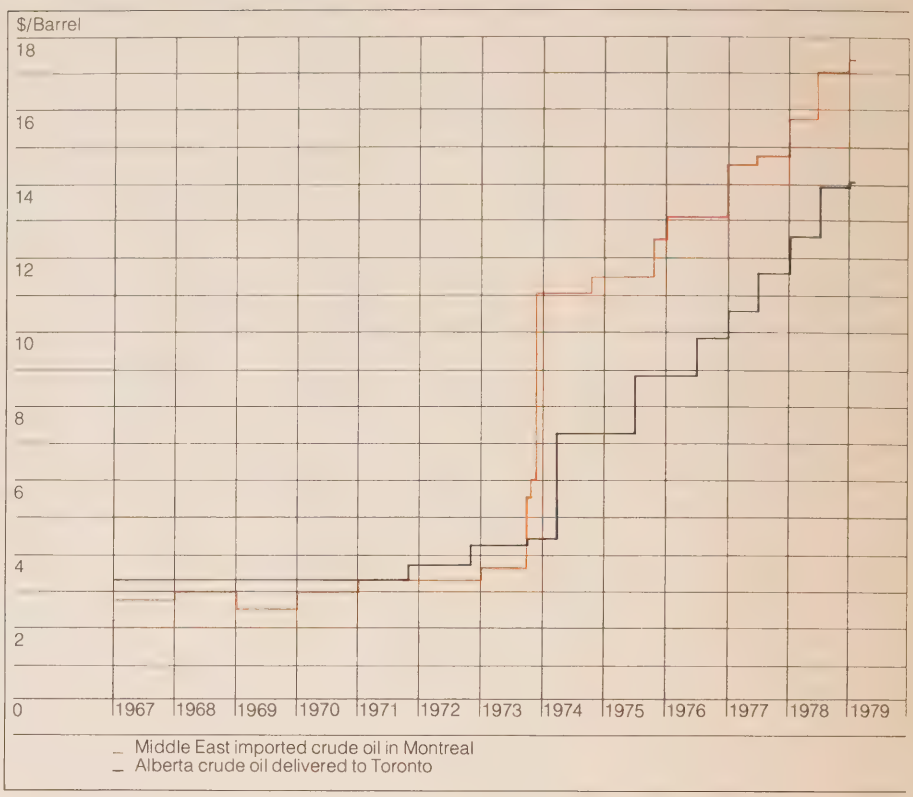
World Oil Prices

In 1973, following OPEC's decision to raise oil prices, the cost of a barrel of Arabian crude oil landed at Montreal rose sharply from about three dollars until it reached nearly twelve dollars in 1974 (Figure 32). Since then it has continued to climb at a slower rate until very recently.

In December 1978, the thirteen members of the Organization of Petroleum Exporting Countries (OPEC) announced their decision to raise their oil price further by 14.5 per cent in four stages during 1979. Since then, events in Iran led to sharp increases in the prices for spot purchases of crude oil. OPEC decided to move ahead its schedule of price increases and to implement the full increase on April 1. They also agreed that OPEC members could implement additional surcharges in light of their own circumstances and those of the market.

By mid-1979 the cost of a barrel of Arabian light crude oil landed at Montreal reached $19 a barrel.
On 29 June, OPEC announced that individual members could raise their official selling prices to between $18 and $23.50 (U.S.) a barrel from 1 July. These prices are equivalent to landed costs at Montreal of between $23 and $29 a barrel in Canadian funds.

FIGURE 32: World and Canadian crude oil prices



Canadian Oil Prices

From 1973 to 1978, Canadian oil prices rose as shown in Figure 32. Canada, with its own supplies of oil and other fuels, has been in a more favourable position than other industrialized nations. The federal government's policy is to move the Canadian domestic price for crude oil towards world levels.

To protect Canadians from the severe economic consequences of the very sharp increases in world oil prices, the government of Canada established a single national oil price adjusted for transportation. After discussions with the provincial governments to determine the level, the average Alberta wellhead price was raised to $6.50 a barrel in April 1974. As of 1 January 1979, the wellhead price is $12.75 a barrel. The federal government has announced that it has reached a new agreement with Alberta to implement two further $1 per barrel price increases on 1 July 1979 and 1 January 1980. These increases are conditional on not exceeding the composite U.S. crude oil price at Chicago.

In July 1978 the federal government introduced a levy of 10 cents on each barrel of Canadian and imported crude oil and of imported petroleum products for processing or consumption in Canada. The revenues from this levy are to be used to pay the difference between world and Canadian crude oil prices for synthetic crude oil. The federal government decided to increase this levy by an additional 23 cents from 1 January 1979.

Canadian Natural Gas Prices

Since 1973 the price of natural gas at the Toronto City Gate has increased from $0.47 to $2.00 per thousand cubic feet. In 1975 the price of natural gas was related to the price of crude oil and currently is set at about 85 per cent of the delivered crude oil price in Toronto.

The immediate outlook for natural gas prices is uncertain. Various schemes of incentive pricing for natural gas to enable it to penetrate new markets are under discussion.

Coal Prices

The price of coal has risen sharply over the past few years. For example, the average coal cost to Ontario Hydro has almost tripled, from $0.47 per million BTU (MMBTU) in 1973 to $1.27/MMBTU in 1977. Ontario Hydro is now paying about $35/ton ($1.30/MMBTU) for U.S. coal delivered to southern Ontario generating stations. Most of these coal purchases are covered by long-term contracts lasting until the late 1980s containing renewable clauses and with pricing arrangements in many cases that are cost-based. The delivered price for western Canadian coal in southern Ontario is some 30 per cent more than for U.S. coal because of the higher transportation costs.

Large industrial users such as Ontario's steel companies located near the Great Lakes are paying about $1.80/MMBTU for coal delivered from United States mines.

Uranium Prices

The current international market price for uranium is about $95 a kilogram. Ontario Hydro has secured its supplies of uranium for its operating and committed nuclear stations (including Darlington) under long-term contracts with two Canadian producers – Denison Mines Ltd and Preston Mines Ltd.

Under the terms of these contracts the price charged to Ontario Hydro is related to a base (cost-determined) price and the difference between this base price and the world market price. It is expected that Ontario Hydro's prices will be lower than world prices over the long term.

Renewable energy sources accounted in 1978 for 13 per cent of the province's energy supply, primarily water-power.

The term renewable energy normally refers to water-power, direct solar energy, wind energy, biomass energy (from renewable organic materials), tidal and wave energy, and geothermal energy (heat from inside the earth).

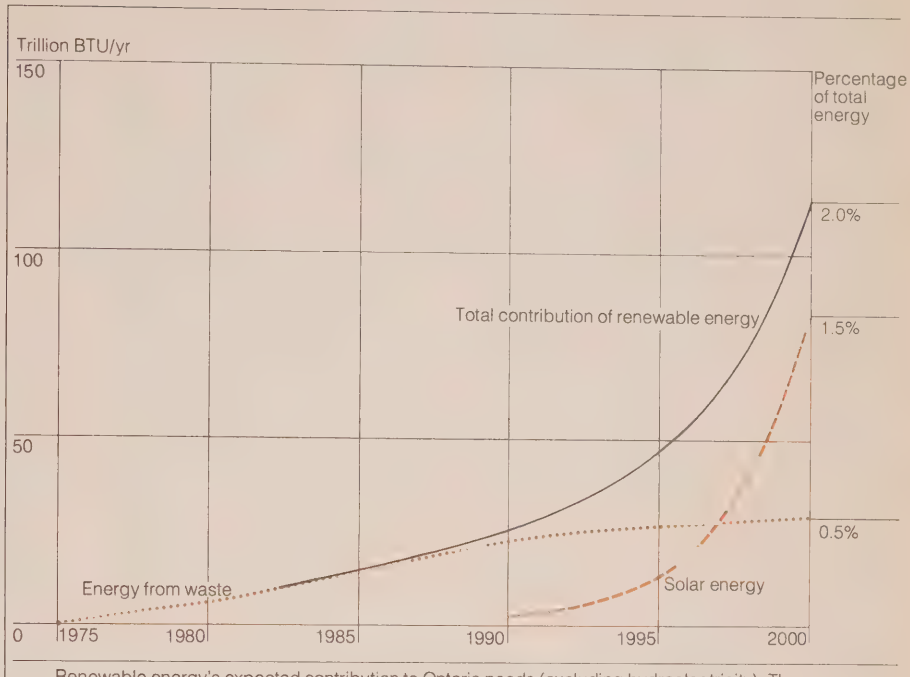
The wide use of water-power to produce hydraulically generated electricity in Ontario has already been discussed.

Sources of renewable energy other than water-power might account for up to 2 per cent of the province's energy requirements by the year 2000 (Figure 33). However, even to achieve that level in so short a time presents a major challenge. Although 2 per cent does not sound like much, it would represent enough energy to heat almost one million single-family dwellings.

Economical renewable energy is crucial to Ontario's long-term energy security, and the Ontario government has been contributing substantially to its development. Under the new five-year $58 million Canada/Ontario bilateral energy agreement, the Ontario government will contribute $29 million for demonstration of new technology in renewable energy and energy conservation; this sum will be matched by the federal government.

Of the many types of renewable energy, some, such as geothermal and tidal, are not practical in Ontario and others, such as photovoltaic conversion of sunlight to electricity, would require major research programs, which are currently being carried out in the United States. Ontario's renewable energy program concentrates on three main areas: energy from renewable organic materials and wastes, solar space and hot water heating, and remote power systems (wind and small-scale hydraulic systems for the generation of electricity).

FIGURE 33: Renewable energy's contribution



Renewable energy's expected contribution to Ontario needs (excluding hydroelectricity). The major contribution in the 1980s is expected to come from energy from waste. Solar energy systems are not expected to make a sizeable contribution until the 1990s, although they will rapidly surpass waste thereafter as an energy source. Reaching the target of 2 per cent of the province's energy needs from renewable sources by the year 2000 will require more than $5 billion in private investment.

Energy from Renewable Organic Materials – Biomass

With the target of meeting 0.5 per cent of the province's energy requirements by 2000 through wood, agricultural, and other organic materials, the Ontario government has several programs underway.

The province recognizes the potential of growing biomass for energy. The Ministry of Natural Resources has developed a rapidly maturing (ten years instead of thirty) hybrid poplar for producing forest resources. The primary aim of the program is to enhance the competitive position of the Ontario forest industry, but the idea of cultivating these trees specifically for their energy content also holds considerable promise.

Wood was once widely used as a fuel, but is now only economical as a residential and commercial heating fuel when an adequate supply is located near the market. When a face cord (or one-third of an actual cord) of wood costs more than $40 delivered in Toronto, fuel oil would have to cost $1.25 a gallon before wood burning became economically competitive. An inventory of Crown woodlands is being compiled to assist in the identification of fuel wood within a reasonable distance of urban centres.

Every year in Ontario some 6 million tons of municipal waste are generated by residential and commercial establishments. The forest industries generate an estimated 1.4 million oven-dried tons a year of wood waste. And farm animals in Ontario produce an estimated 5.9 million tons of dry manure annually. These wastes pose disposal problems. They also represent a potential source of energy.

The direct burning or gasification of waste material is an important part of Ontario's renewable energy program. The target is to assist in the production of energy equivalent to five million barrels of oil from currently unutilized wastes by 1990. This will require eight to ten plants to convert 1000 tons a day of waste.

The Ontario government has undertaken specific projects to extract the energy potential of the following types of waste: forest, municipal/industrial, and agricultural.

The energy potential of forest residues (primarily mill waste) could assist the pulp and paper and lumber industries to improve their competitive position as conventional energy prices increase.

The Wood Waste Energy Study at Hearst, Ontario, showed that the 129,000 tonnes of oven-dried wood waste disposed of annually in landfill sites or incinerators would allow an energy plant to generate 14 megawatts of electricity at peak and produce an average of 78,000 lb/hr of steam from the available waste. However, the economic feasibility of the proposed plant would be marginal under present conditions. As a result of the study Shell Canada is now investigating an alternative project using the waste to produce wood pellets as a substitute for fossil fuels in industrial boilers.

One answer to the growing problem of municipal waste disposal is to convert it to useful energy. A plant in North Bay, which would recover energy from garbage and sewage sludge as well as local wood waste, is the subject of a study involving the Ministry of Energy in conjunction with the City of North Bay and Nordfibre Company. The waste would be used to produce the majority of the steam used at the Nordfibre plant.

Watts from Waste, a project involving the Ministry of the Environment, is investigating the possibility of burning 420,000 tons a day of Metro Toronto garbage in one of Ontario Hydro's existing generating stations. Because of large cost increases a review of the project is in progress.

Further studies to determine the feasibility of energy recovery, either as steam or electricity from municipal waste, are underway in the Municipality of Peel, in the City of Toronto, and in several other centres.

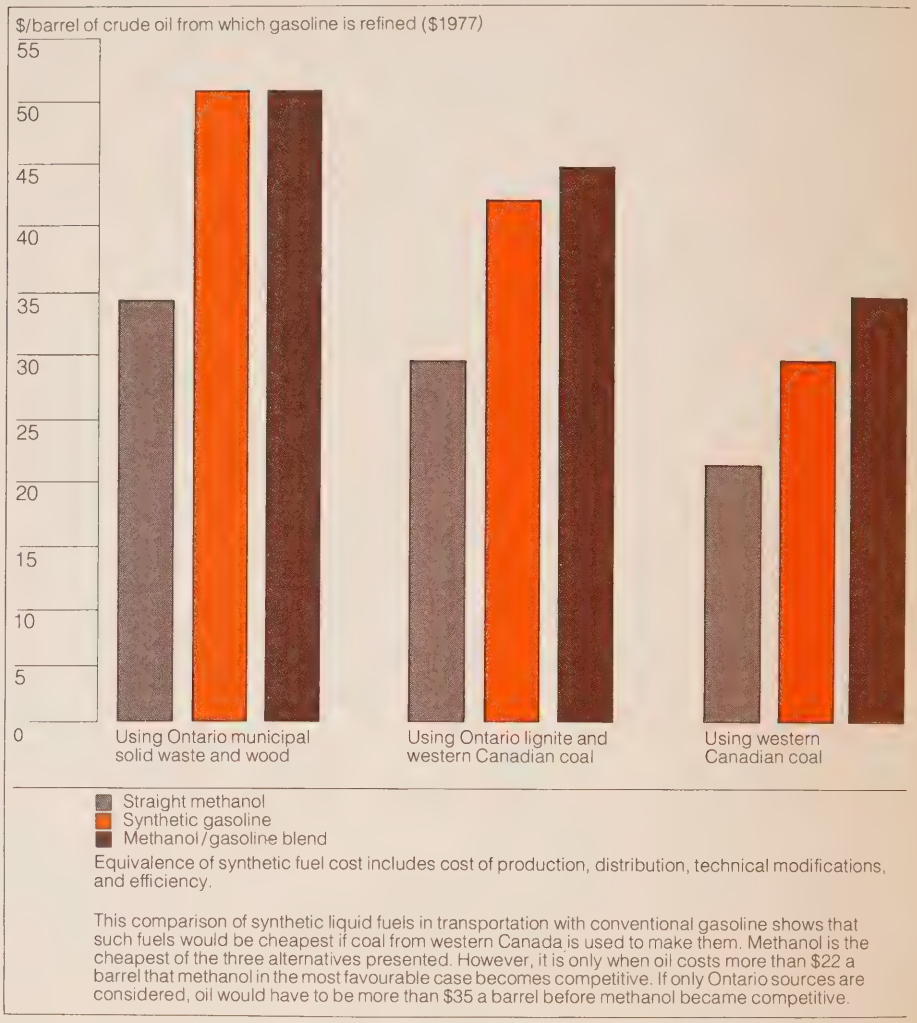
Some energy potential exists for recovery of Ontario's agricultural residues – crop residues, cereal straw, and animal manure – but of the crop residues only grain corn represents possible material for fuel production. Because of the limited quantities recoverable, the high collection costs, and the alternative uses on the farm, it does not appear to be desirable to use crop residues for energy production in a centralized facility. Methane gas production from animal waste may have potential, however, and on a farm scale is being demonstrated at the Arkell Swine Research Centre.

Synthetic liquid fuels, such as methanol, ethanol, and synthetic gasoline, manufactured from wood, municipal solid wastes, and non-renewable deposits of lignite coal could replace 6 per cent of Ontario's forecast annual oil requirements in the year 2000 if cost were disregarded.

If the lignite and municipal solid wastes are excluded, leaving only wood as a source, the possible extent of replacement is reduced to 4 per cent. While the manufacture of these synthetic liquid fuels is possible, it is estimated they would be 50 to 100 per cent more costly than gasoline produced from crude oil even at $30 a barrel in 1977 dollars (Figure 34).

Rather than converting Ontario's renewable resources into a liquid fuel, a Ministry of Energy Advisory Group has concluded that for the time being at least they would be better utilized through direct burning and gasification, both of which are more energy-efficient. The production of a synthetic liquid fuel from western Canadian coal, while more attractive, would be economically justified only at a crude oil price of $30 a barrel.

FIGURE 34: Comparison of synthetic liquid fuels in transportation with conventional gasoline



Equivalence of synthetic fuel cost includes cost of production, distribution, technical modifications, and efficiency.

This comparison of synthetic liquid fuels in transportation with conventional gasoline shows that such fuels would be cheapest if coal from western Canada is used to make them. Methanol is the cheapest of the three alternatives presented. However, it is only when oil costs more than $22 a barrel that methanol in the most favourable case becomes competitive. If only Ontario sources are considered, oil would have to be more than $35 a barrel before methanol became competitive.

Solar Energy

Ontario's solar heat energy program aims to meet 1.5 per cent of Ontario's energy requirements by the year 2000 by assisting the private sector in achieving the commercialization of solar technology. Meeting this target would require an estimated capital investment by the private sector of $4.6 billion in 1979 dollars.

There are two basic types of solar heating systems: passive solar systems (where the building itself collects and stores heat) and active solar systems (where a separate heat collection, storage, and distribution system is attached to a building).

Ontario is developing and promoting commercial acceptance of both passive space heating and active solar systems, particularly for hot water preheating.

An important aspect of solar energy is the legal question of access to sunlight, 'the right to light,' because even the best solar collector is useless without sunlight. The Ministry of Energy has issued a discussion paper called 'Perspectives on Access to Sunlight,' which outlines existing law on solar rights and examines a number of possible legal methods to protect solar access in Ontario.

Similarly, a system to rationalize shading will be studied to assist planning for the use of solar energy systems in urban areas.

Solar space and hot water heating systems have been installed at the Aylmer Senior Citizens' Residence (Figure 35). A major feature of this two-storey, thirty-unit building is a heat reservoir tank holding 200,000 gallons of water, which will store energy collected in the summer for use in the fall and winter.

Other projects include the design of solar space heating for row housing, solar preheating of domestic hot water, and a packaged solar space heating system, being tested in an existing Ontario Housing Corporation house.

FIGURE 35: Aylmer Senior Citizens' Residence showing solar panels on roof

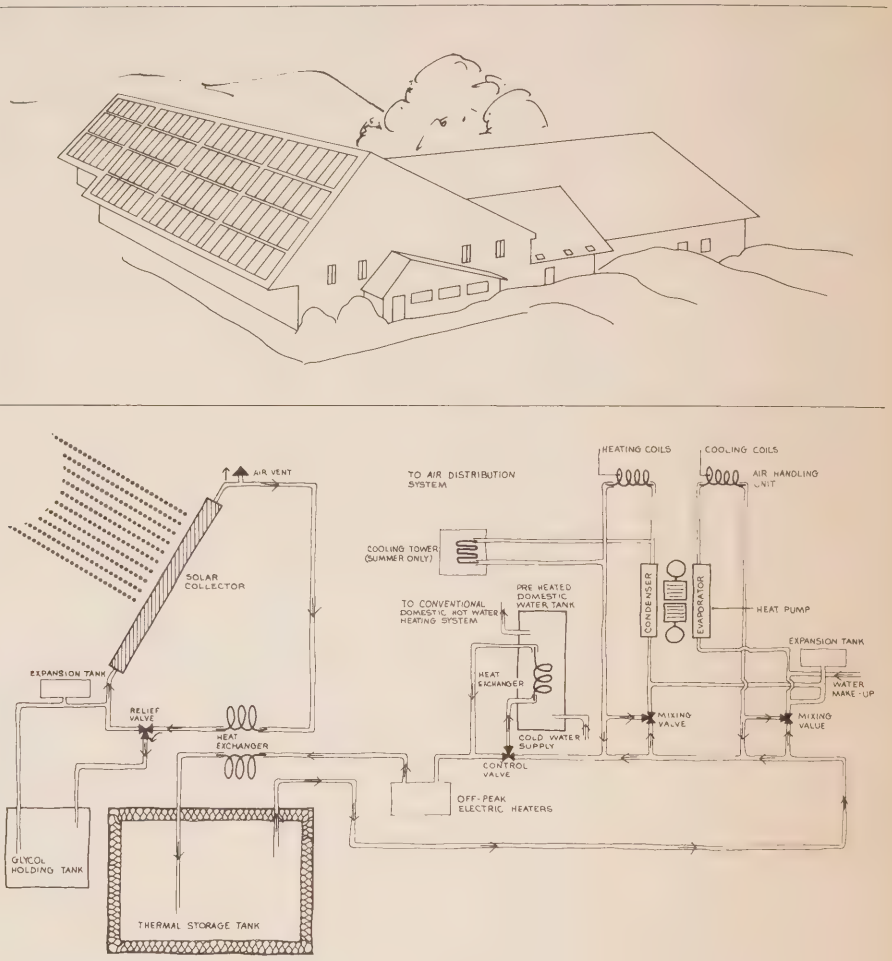
A wide range of commercial and institutional buildings including schools, hospitals, correctional institutions, and community centres are involved in Ontario government solar energy projects. Canada's first solar-heated school – Applewood Public School – officially opened in St Catharines in February 1979 (Figure 36). A solar-assisted heat pump system designed to supply three-quarters of the space heating and hot water requirements has been installed at the school, which has eight classrooms used by more than 200 students. This is the largest and most complex solar energy demonstration project undertaken by the Ontario Ministry of Energy to date.

A solar energy system was installed at West Humber Collegiate in Etobicoke to provide about 50 per cent of the school's hot water heating requirements. And at Confederation College of Applied Arts and Technology in Thunder Bay, solar panels are being installed to provide hot water for a new 150-unit residence being built on campus.

Other projects include a solar heating system for the outdoor swimming pool at the Richvale Community Centre in Richmond Hill, a feasibility study for solar water heating at the Brampton Correctional Institution, and a solar hot water system at the Oakville-Trafalgar Memorial Hospital. Hydro's new training centre in Mississauga will have solar collectors and heat exchangers to provide hot water for the building. Solar heating applications in provincial parks are also under consideration.

An agricultural application of solar energy sponsored by the Ontario government is the design of a solar heating system on a swine-rearing building at the Arkell Swine Research Centre. An experimental grain-drying unit is being tested. An evaluation facility is being established by Ontario Hydro in co-operation with the Ministry of Energy to assist manufacturers in developing residential solar water heating products and to provide information leading to the development of standards.

FIGURE 36: Applewood Public School showing solar assisted heat pump system



Applewood Public School
St Catharines, Ontario

Building	– 20,000 sq. ft public school – high levels of insulation throughout the building
Heating system:	– solar assisted heat pump to provide partial solar heating – off-peak electrical auxiliary heating – air conditioning
Collector:	– 2,480 sq. ft liquid collector (Solco Energy Systems) – single glazed with selective surface
Storage:	– 100,000 lb. (10,000 gal.) water – water stored in insulated tank adjacent to building
Distribution:	– forced air system using multi-zone air handling units

Remote Power Systems

Since there are still some isolated communities in northern Ontario not connected to an electrical power system, a number of renewable energy systems have been assessed by government as potential alternatives to transmission line extensions or supplements to diesel installations. These include small-scale hydroelectric units, combined wind-diesel power systems, and wood-fuelled generators.

Studies of wind-power during the last three years have found that the wind characteristics in Ontario are unsuited to economic application of wind generation in the next ten to fifteen years in areas served by central electrical power systems. But there is potential for application of wind-power in remote areas served by diesel systems if fuel costs are in excess of one dollar a gallon in 1976 dollars.

A 13-metre-high windmill was constructed in combination with a diesel generator on Toronto Island to demonstrate the economic feasibility of similar installations in the remote northern areas not connected to Ontario Hydro's power grid (Figure 37). The second phase of the project is to construct and operate an improved higher-powered version in northern Ontario.

In northern Ontario there is still some undeveloped hydraulic capacity at several existing sites. A number of developments in small-scale (less than thirty-foot head) hydraulic turbine units have opened up a new range of applications, particularly for community power in remote areas. A small-scale hydraulic turbine is now being demonstrated at Wasdell Falls, and four other locations are being studied by Ontario Hydro.

FIGURE 37: Toronto Island wind demonstration project

This windmill, thirteen metres high, was constructed on Toronto Island to demonstrate the economic feasibility for similar installations in remote northern areas. The project combined a windmill with a diesel generator installation. When the wind blew at speeds over 13 km/h (8 mph) and below 105 km/h (65 mph) the windmill took over part of the generating function from the diesel. The windmill was capable of generating up to 10 kilowatts of electricity. The vertical-axis vanes are a recent Canadian development.

Energy conservation in Ontario is a desirable and increasingly essential activity. The Ministry of Energy would like to see the provincial rate of growth of demand for energy reduced to 2 per cent a year by 1985. This compares with a growth rate of 3.9 per cent from 1966 to 1976.

By initiating, co-ordinating, and funding various energy management programs, the Ministry's goal is to encourage voluntary energy conservation efforts by citizens of Ontario, based on enlightened self-interest.

Recent indications suggest that the public is becoming more conscious of the importance of energy conservation and that energy consumption is being reduced. A recent analysis by the Canadian Gas Association of the annual consumption of natural gas per residential space-heating customer indicates that in Ontario between 1972 and 1977 the average space heating use per customer, after adjustment for temperature variations, decreased by 7.9 per cent (Figure 38).

In the City of Toronto recent figures from Toronto Hydro show electricity demand grew during 1978 only one-half of 1 per cent, compared to past years when the annual growth rate was 5 per cent. There has also been an actual reduction in peak load (Figure 39), the first significant reduction since 1911 (barring minor anomalies such as conversion to 60-cycle and transfer of Leaside customers to the East York system).

FIGURE 38: Average use of natural gas per residential space heating customer in Ontario

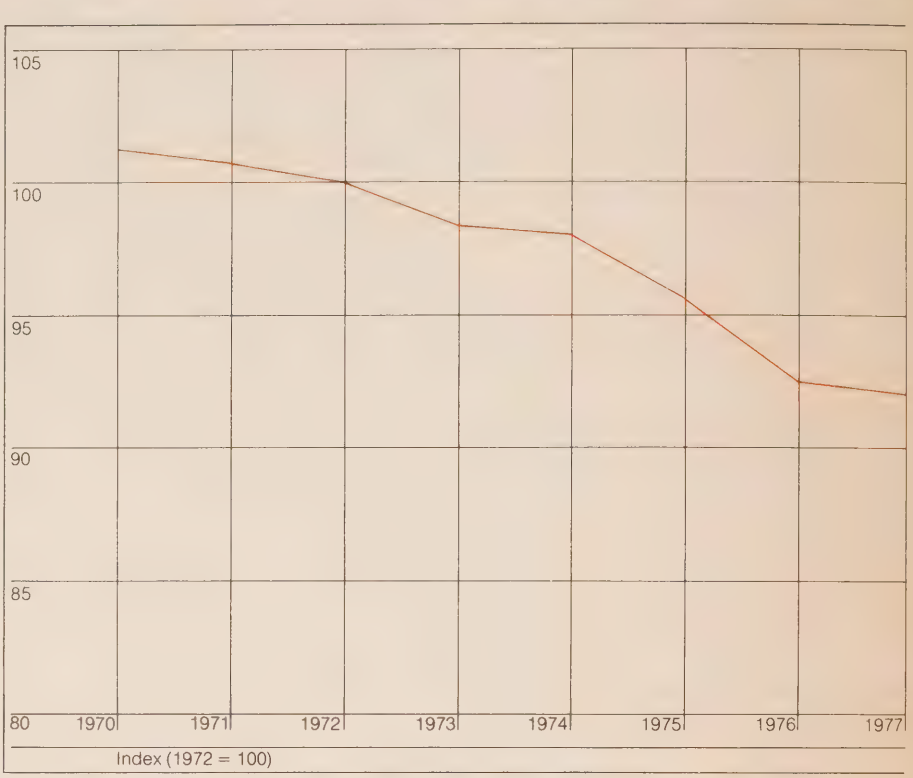
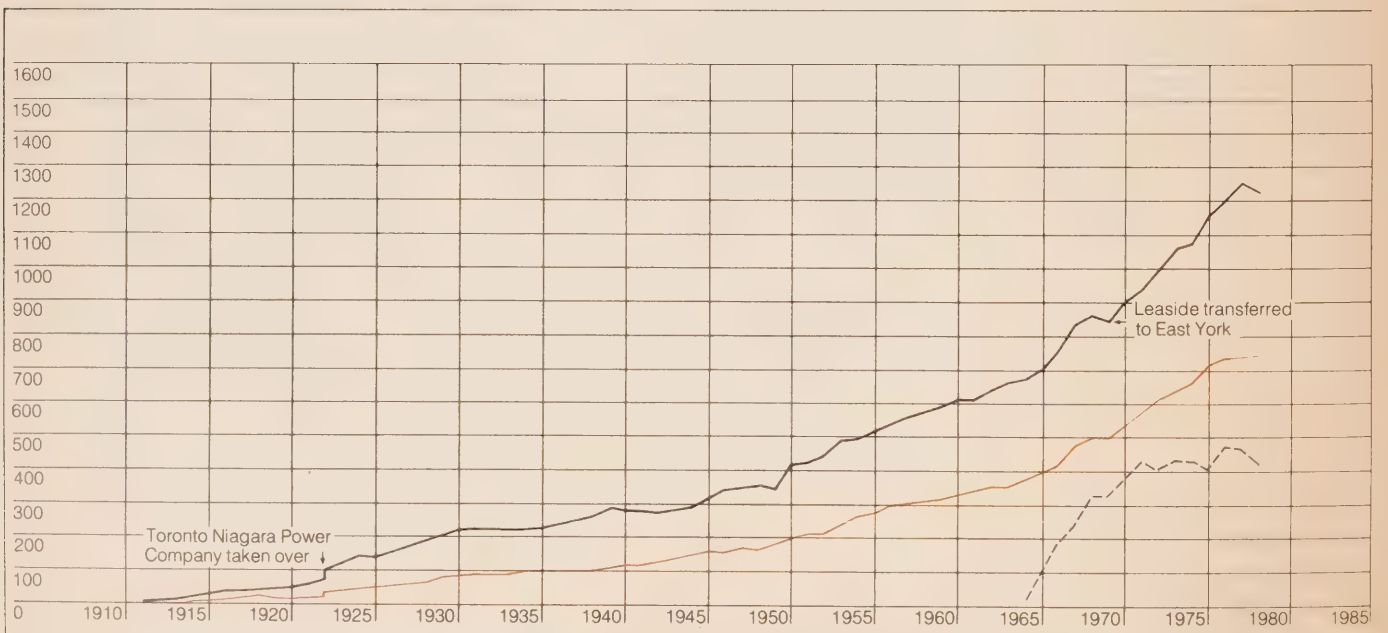


FIGURE 39: Toronto Hydro-Electric System peak load decreases for the first time since 1911



In 1978, the drop in Toronto's peak demand was the first significant reduction (barring minor anomalies) since 1911.

Residential

The major way for the homeowner to save energy is to reduce heat loss from the home. Ontario homeowners are being assisted in their efforts to save energy in a variety of ways including: practical homeowner insulation clinics, retraining courses for heating technicians, and financial and technical assistance towards preparation of an energy conservation manual for the construction industry.

The Ontario government also encourages residential energy conservation through removal of the provincial sales tax on energy conservation materials and equipment. Such exemptions are valued at $30 million for fiscal year 1978-9.

Thermography information clinics have now been held in three Ontario centres – Lindsay (the first in Canada), Stratford, and Peterborough. Infrared scanners mounted on an aircraft detected heat lost from buildings, and the resulting thermograms – showing heat escaping from buildings – are discussed with individuals who attend the clinics to identify heat loss problems and possible solutions (Figure 40). Insulation displays and literature provide additional information on how the problems might be corrected.

The Lindsay experiment was repeated in Stratford in March 1978, and in February 1979 the project was taken to the much larger city of Peterborough, with the assistance of the local public utilities commission. Results show that thermography interpretations were done for 32 per cent of the owner-occupied dwellings in Stratford, 56 per cent in Lindsay, and 37 per cent in Peterborough.

Home energy audit questionnaires have been widely distributed to Ontario homeowners. Computer calculations show homeowners how to save heating dollars and energy, what various measures will cost, and how much energy they will save.

Improved gas-fired furnaces and hot water appliances have been designed and tested in co-operation with the Canadian Gas Research Institute. This research has led to the commercial development of a natural gas-fired furnace with a seasonal efficiency above 75 per cent for homes with forced-air circulation systems. A longer-range effort – the design, construction, and laboratory testing of radically new natural gas home furnaces and water heating units to achieve greater fuel efficiency – is underway.

Retraining courses at community colleges have begun for oil burner mechanics to enable them to make detailed performance tests during annual inspections and cleanouts of home furnaces. Similarly, courses instructing mechanics how to fit devices that improve the efficiency of existing furnaces will also be offered.

FIGURE 40: The Stratford Thermography Clinics
Thermograph showing homes with good and bad insulation

At a thermography information clinic in Stratford, homeowners looked at images (thermograms) showing where heat is escaping from homes. The thermograms here show a poorly insulated home (left) and a well-insulated home (right). The light patch in the well-insulated home shows heat is escaping only from the chimney.

Commercial

The goal in this sector is to reduce energy consumption in publicly funded buildings and promote a similar response in the private commercial sector.

Improvements have been made to existing Ontario government buildings and thermal performance guidelines established for new government buildings. A goal to reduce energy consumption by 15 per cent over five years in existing Ontario government buildings has been established. These buildings occupy an area of 35 million square feet. Annual savings on the order of $600,000 are expected to flow from this program.

Impressive energy savings have already resulted, with one building at 361 University Avenue in downtown Toronto cutting energy consumption in half over two years (Figure 41). Savings of $100,000 a year on the energy bill for this building are being achieved.

Thermal performance guidelines for all new government buildings have been established. Designs for new buildings in excess of 100,000 square feet will be subjected to a computer analysis in order to minimize energy consumption requirements. Ways to incorporate renewable energy and waste heat recovery systems into such buildings are being examined.

Assistance is being given to the Royal Architectural Institute of Canada in the preparation of an energy conservation handbook for use by the design, construction, and property development industries. The handbook will include design principles, codes and standards, and design criteria for new construction.

'Seed money' supplied by the Ministry of Energy has been used by other Ministries to hold seminars, establish energy consumption records, and implement projects in existing public buildings, including universities, community colleges, general hospitals, primary and secondary schools, and public housing units. The Ministry of Colleges and Universities has already achieved its over-all five-year objective of a 15 per cent reduction in energy consumption in its institutions. Energy cost savings in correctional institutions have amounted to 25 per cent over the past two years. And some hospitals have cut their energy costs by one-third.

Energy conservation programs are also underway in the private sector.

A program aimed at downtown Toronto commercial buildings was started in April 1978 by Premier William Davis inviting the owners of downtown office buildings and their tenants to participate in a five-point co-operative program designed to promote wise energy use in commercial buildings. Twenty-nine companies have appointed energy conservation officers who will be responsible for conservation programs within their organizations.

The goal of the program is to reduce energy consumption by at least 30 per cent from 1973 levels, measured in energy consumption per square foot. Participating organizations have been asked to set corporate objectives for reducing lighting levels, particularly during evening hours.

Ontario's local and regional governments spent more than $100 million in 1977 on energy-intensive services such as street lighting, transit, waste collection and disposal, recreation, and services in buildings. For instance, energy savings may be possible in the more than nine hundred rinks and arenas in Ontario, which consume large amounts of electricity for lighting and ice-making equipment.

An Ontario Hydro program involves all major food chains, hotels, restaurants, and arenas. Hydro is also conducting extensive reviews of building and street lighting. For its part, Hydro over the past two years has achieved a reduction in its own annual energy use of 175 million equivalent kilowatt hours, or 19 per cent.

Transportation

Since the early 1970s the energy consumption in transportation has grown at 4.5 per cent per year. In all, transportation represents more than one-quarter of the total secondary energy consumed in the province. Ontario's transportation system is almost totally dependent upon oil. Consequently, measures to develop alternative transportation fuels as well as a more efficient use of petroleum products and less energy-intensive travel patterns are being examined.

Reduced speed limits on Ontario's highways and major roads were introduced in 1976. During that year this measure is estimated to have saved from 33 to 83 million gallons of motor fuel.

Car pools and van pools are seen as a way to reduce energy consumption and ease rush hour traffic. Demonstration of carpooling incentives such as rider matching and preferential parking is being carried out by the Ministry of Transportation and Communications for its employees.

A number of technological methods of achieving higher fuel efficiencies in cars and trucks are also being investigated.

To encourage greater use of public transit the Ontario government provided subsidies to municipalities of $189 million in 1977 and $243 million in 1978 under its Transit Assistance Program.

FIGURE 41: Energy-conserving Ontario Government building at 361 University Avenue, Toronto

Energy use at this large office building on University Avenue in downtown Toronto was cut in half over a two-year period. Changes to the heating system and the efforts of an enthusiastic operating staff contributed to the energy and dollar savings

Urban Development

Improvements to the design of new subdivision and downtown areas can result in significant energy savings. Plans for a subdivision in Guelph are being examined together with modifications altering density, road lengths, and the direction buildings face to determine the potential for energy savings through subdivision design.

District heating – the provision of heat from a central source to a number of buildings through a central distribution system – is of particular interest. Efforts to date include development of a financial model to assess investment risk, examination of the feasibility of central heating systems for urban redevelopments in the St Lawrence Market area of Toronto and in Sarnia, and an engineering design and cost estimate for district heating in a community of about 20,000, such as the proposed community of North Pickering.

Industrial

In 1975, to encourage greater awareness among industrial decision-makers of energy use and energy costs in production processes and the adoption of energy conservation techniques, Ontario introduced the first energy bus program in Canada. These computer-equipped buses assist businessmen in making an on-the-spot analysis of energy consumption and identification of potential savings. So far about nine hundred companies have been visited in Ontario and annual cost savings of $40 million identified.

Ontario Hydro is training more than two hundred energy conservation surveyors from Hydro and municipal utilities to examine some 12,000 small-to-medium industrial plants in the province. Hydro also conducts seminars on industrial energy conservation in various Ontario centres.

In December 1978, a seminar on the industrial cogeneration – simultaneous generation of electricity and useful thermal energy (principally steam) – enabled senior representatives of business and government to exchange views on the technical merits and economic difficulties of increasing the province's cogeneration capacity.

Research into soil-warming methods and greenhouse designs is being conducted to increase crop yields without increasing energy consumption.

The reduction of energy consumption in farming through improved and reduced tillage operations is being investigated.

Since 1977, the Ontario Energy Corporation has been studying the use of by-product heat from nuclear generating stations in greenhouses, fish hatchery operations, and commercial fish-rearing facilities. A joint venture with industry is now underway to build a prototype greenhouse at Bruce. A test greenhouse facility is already in production at Pickering.

Three Possible Futures

The first part of this report outlined Ontario's present energy picture. This part looks to the future.

In planning for the future it is possible to take either of two approaches. One approach is to select a target level of energy consumption and then force events in order to achieve that level, such as by prescribing how much energy each individual would be allowed to use. Another method, the one used in this analysis, is to forecast the growth in energy consumption, using current trends and anticipating events to identify potential future problems. Then, by taking appropriate action, it may be possible to avoid those problems.

The simplest kind of forecast merely projects the province's current energy consumption patterns forward to, say, the year 2000 to see where they are leading. However, significant changes could obviously occur in the structure of energy supply and consumer demand over the next twenty years. To take account of such possibilities, forecasters construct a model that allows certain basic assumptions about the future to be altered. They are then able to present a range of possible future consumption patterns.

The Ministry has developed a forecasting model that enables us to project energy demand over the next twenty to twenty-five years using a variety of different assumptions. The model is useful for quantifying the effect on future energy use of technological changes and socio-economic developments.

Using this forecasting model, the Ministry has developed three plausible alternative energy futures or 'cases' for the province.

Obviously no one can accurately predict future events, but the value in trying to anticipate energy supply and demand comes from the heightened awareness and greater sensitivity to the various factors interacting in and shaping the future. As a result of this greater awareness one is able to take action earlier than might otherwise have been possible.

The major assumptions made by the Ministry in all three cases are as follows:

- there will be no major technological breakthroughs affecting energy use;
- only policy measures that are currently implemented, or widely accepted as sure to be implemented, are considered;
- no major social or political upheaval will radically change the structure and pattern of energy use;
- the marketplace will continue to determine resource allocations;
- consumers will actively pursue energy conservation opportunities;
- alternative energy sources will make only a very small contribution to Ontario's total needs during the next twenty years;
- the Ontario economy and population will develop along the lines forecast by the Ministry of Treasury and Economics.

The three cases differ only in their assumptions regarding energy price, fuel availability, energy use efficiency, and technology. They can be described as follows:

Case 1: Current Trends assumes only those energy use technologies currently in commercial application. Canadian oil prices approach world oil prices by the early 1980s and stay at world levels thereafter, increasing slowly in real terms till 2000. The different fuels become more price-competitive, but their relative positions remain unchanged.

Case 2: Low Energy Use assumes more rapidly increasing energy prices and higher levels of conservation in the later years. Natural gas, coal, and electricity prices maintain the same competitive relationship with oil as in Case 1.

Case 3: Uncertain Oil and Natural Gas Supplies reflects mounting concerns about oil and natural gas availability, leading to increasing choice of electricity, coal, and alternative energy sources, together with further adoption of new energy use technology.

A more detailed description of the different assumptions used in the three cases is presented in Figure 42.

FIGURE 42: Ontario energy demand outlook: major assumptions

		Residential		Commercial		Industrial	Transportation
		Old housing	New housing	Old stock	New stock		
Case 1 Current Trends	Conservation	Thermal upgrading (20% savings) Heating efficiency (5% inc.)	Revised Building Code by 1980 (30% savings in heating demand)	Better housekeeping measures (up to 15% savings)	Revised Building Code by 1980 (up to 40% savings)	Federal conservation goals achieved by 1985 (up to 15% savings by 1985)	U.S. car fuel efficiency standards by 1985 (40% savings new cars) 35% savings aircraft
	Fuel choice	Some conversion from oil to gas	Natural gas (major share) Electricity 30%	Current market shares No conversion	Natural gas (major share) Electricity captures some of oil market	Current market shares. Coal increases in cement and lime production	Increased dieselization of trucks Dieselization of 7% of car fleet by 2000
Case 2 Low Energy Use	Conservation	Thermal upgrading (30% savings) Devices efficiency (10% inc.)	Revised Building Code by 1980	Increased housekeeping measures Thermal upgrading	Good housekeeping plus further revised standards after 1985	5% to 10% savings on top of Case 1 1990	5% savings on top of Case 1 (new cars) 50% savings aircraft 10% to 30% savings in trucking
	Fuel choice	Same as Case 1	Same as Case 1	Shift from oil to gas after 1985	Some heat pump penetration in office and retail	Same as Case 1 Increased self-generation of electricity	Higher trucking dieselization Dieselization of 25% of car fleet by 2000
Case 3 Uncertain oil and gas	Conservation	Same as Case 2	Same as Case 2	Same as Case 2	Same as Case 2	Same as Case 2	Same as Case 2
	Fuel choice	Conversion to electricity after 1985	Some active solar Electricity 50% by 2000	Some shift to electricity after 1985	Some solar and coal in institutions High heat pump saturation (office and retail)	Limited switch to electricity High coal penetration (40% by 2000) Same self-gen. as Case 2	Very low methanol gasoline blend Same dieselization as Case 2

All sectors: Basic common socioeconomic factors
Ontario population growth rate: 1.2% per year (1976 - 2000)
Ontario Real Gross Provincial Product growth rate: 4.8% per year (1976 - 1985)
3.9% per year (1986 - 2000)

Secondary (End Use) Consumption

In each of these three cases, projections of end use or secondary energy demand have been developed for the Residential, Commercial, Industrial, and Transportation sectors.

As before, the Residential sector includes households; the Commercial sector includes institutional, government, and privately owned commercial buildings, as well as municipal utilities; the Industrial sector includes agriculture, mining, and manufacturing; and the Transportation sector includes road, rail, air, and marine transportation of people and goods.

The energy consumed by refineries, pipelines, and electrical generating stations and that used for non-energy purposes such as plastics, lubricating oil, nylons, and so on are excluded from secondary energy consumption.

The projections of end use demand for the four sectors were developed by estimating the size and the characteristics of the future stock of buildings and energy-using machines and appliances and by estimating the differing amounts of energy each would use in the three cases.

The projections for Ontario's energy consumption, with all sectors taken together, are presented in Figure 43 by sector and in Figure 44 by fuel.

The details of secondary end use consumption for each of the four sectors are illustrated and discussed separately.

The future growth rate of secondary energy consumption by the year 2000 is expected to be lower than in the past (Figure 43). Each case shows energy consumption in the Industrial sector growing faster than in the other three sectors. The Industrial sector's share of the total expands from less than 40 per cent in 1965 and 1975 to about one-half in 2000. Transportation's share remains the same over the period at about one-quarter. The Residential and Commercial sectors' shares meanwhile decline steadily, from 22 and 14 per cent in 1975 to 16 and 10-12 per cent in 2000. The four sectors therefore maintain their current rank in terms of the amount of energy used: Industrial first, then Transportation, Residential, and finally Commercial.

Between 1965 and 1975, gas and electricity's shares of the total market increased, and oil and coal's shares dropped (Figure 44). The projections show oil's decline continuing in every case, with coal and electricity increasing. In Case 3 a reduced gas share is picked up mainly by coal. By the end of the century more than two-thirds of secondary consumption of oil is for transportation.

FIGURE 43: Secondary energy demand by sector 1965-2000

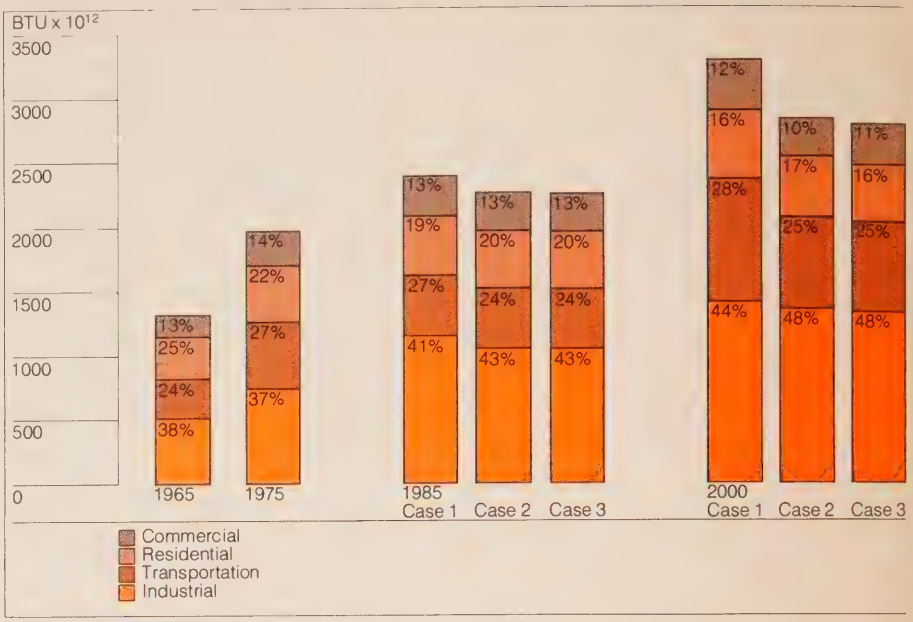
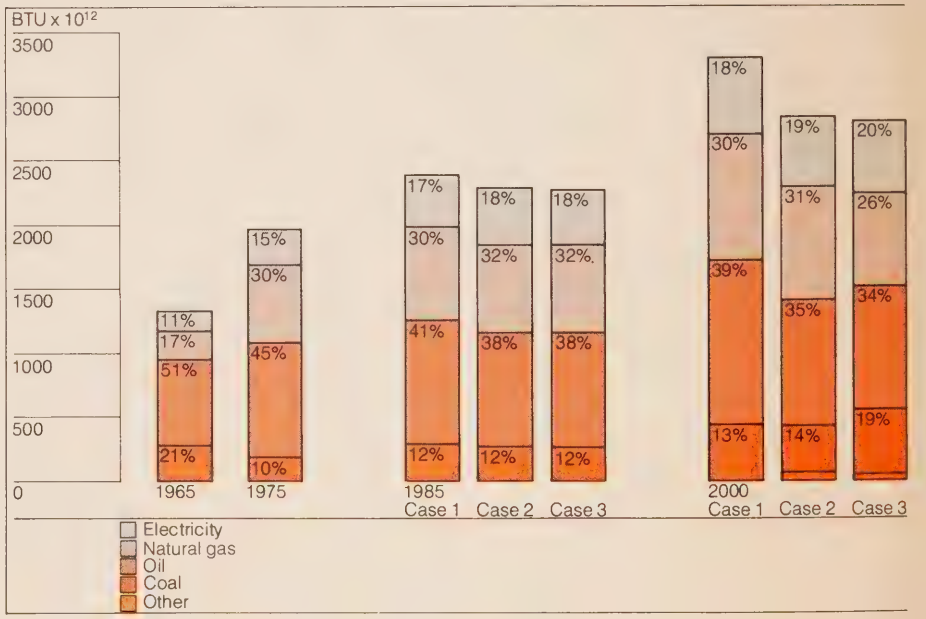


FIGURE 44: Secondary energy demand by fuels 1965-2000



Primary Energy Consumption

To calculate total primary energy demand, the secondary demand of the four sectors is totalled. To this sum is added the amount of energy used by the energy supply industries and that used for non-energy products. This calculation gives the total estimated demand for all primary energy used in Ontario in a particular year.

The recent growth and composition of the province's primary energy consumption are shown in Figure 45. In each case total consumption is expected to rise steadily, though it rises much more rapidly in Case 1, where the increase is 29 per cent from 1975 to 1985 and 77 per cent by the year 2000.

Each case sees a decline in the oil share to one-third by 1985, and in Case 3 to 30 per cent in 2000.

The share of natural gas parallels oil's decline, reaching 18 per cent in Case 3 in 2000.

Coal on the other hand can be seen making a mild comeback, in the last case surpassing natural gas consumption.

The most interesting pattern may be in electricity. Consumption of electricity produced from water-power remains about the same in absolute terms, though its share declines; but nuclear power's share increases from 5 per cent in 1975, to 15 per cent in 1985, and to as much as 22 per cent in Case 3 for the year 2000.

The fact that the growth in primary energy consumption is in all three cases projected to be lower than in the 1960s is a result of the expected slower growth of the Ontario economy and the expectation that consumers and industry will take measures to improve the efficiency of their energy use. The projections in fact show higher growth rates in energy consumption between 1985 and 2000 than between 1975 and 1985.

Sectoral Energy Consumption

The projections of Ontario's secondary energy consumption presented previously were for all sectors taken together. They were based on more detailed projections of energy needs for each sector. For the interested reader these sectoral projections will now be briefly described. Other readers may wish to turn immediately to the next section on the prospects for supply.

Industrial Sector

Figure 46 summarizes the secondary energy consumption of the industrial sector.

Total consumption rose between 1965 and 1975 by 40 per cent.

In the next twenty-five years industrial energy consumption is expected to grow more slowly than in the past.

Total consumption is expected in each case to rise by 30 per cent from 1975 to 1985. By the year 2000 consumption will have nearly doubled from the 1975 level, but significant differences begin to appear between the projections. In Case 1 the rate of growth over the whole projection period is 2.8 per cent a year. In Cases 2 and 3 the rate over the whole period is 2.5 per cent a year.

This reduced consumption rate reflects primarily a slower expected rate of growth in the economy.

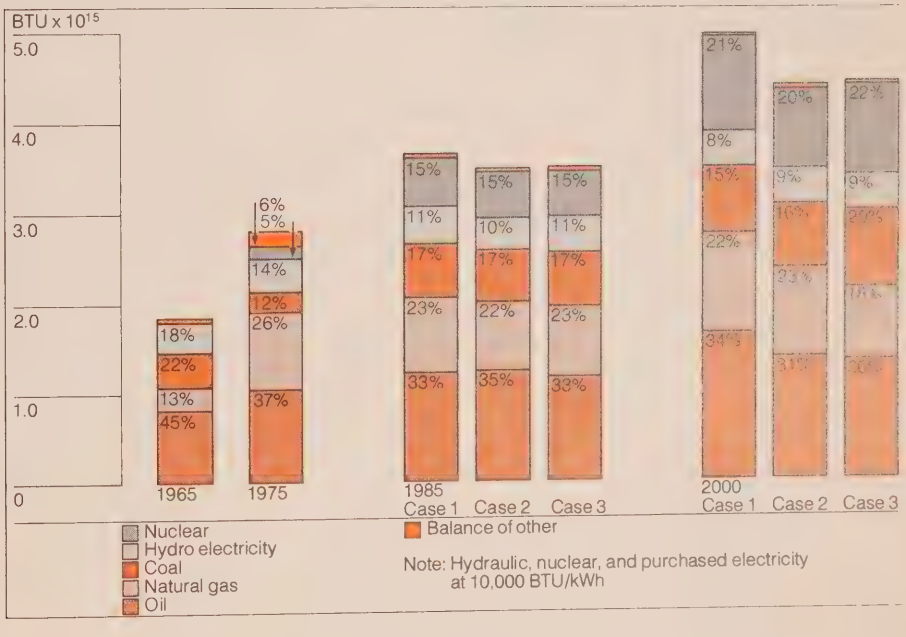
The impact of energy conservation in the Industrial sector is more modest than in the other sectors, in part because industry has already done much to control its energy costs.

As industry expands and as new plant replaces old, it has been assumed that new and more efficient processes are chosen. This change has a significant impact on the level of energy consumed and on fuel choice.

For example, assumptions include an increased use of thermomechanical pulping in the pulp and paper industry, a gradual phasing-out of the open hearth furnace in the iron and steel industry, and increased use of electric boosters and electric furnaces for container production by the glass industry.

The contribution of different fuels to the energy consumption of this sector has changed dramatically since 1965. Between 1965 and 1975 electricity and oil's shares changed little, the former holding at 14 to 15 per cent, the latter dropping slightly from 20 to 18 per cent. In contrast, however, coal was replaced by natural gas as the source of over two-fifths of the energy supply. In absolute terms gas supplies to industry nearly tripled, while coal sank to two-thirds of its former value.

FIGURE 45: Primary energy demand 1965-2000



All three projections indicate that the decline in coal's share will be reversed. The shares of gas and oil will fall marginally, while those of electricity and coal will increase. In Case 3 coal moves strongly to replace oil and gas, increasing its share from 26 per cent in 1975 to 41 per cent in 2000.

The scope for substituting electricity for other fuels in the Industrial sector is limited. There are several reasons for this. Electricity is unlikely to substitute for fossil fuels to a major extent in industries that use large quantities of steam, such as industrial chemicals, pulp and paper, and the food and beverage industry. In other industries, such as iron and steel, and smelting and refining, the use of oxygen-enriched air has significantly decreased fossil fuel consumption, reducing the urgency of seeking substitute fuels.

In addition, electricity-based technologies are often more capital-intensive and have limited capacity.

The 'other' category in the projection for 2000 includes mainly wood wastes and solar energy. The use of wood wastes by the pulp and paper industry is expected to more than double over the projection period. In Cases 2 and 3 it will account for about 0.5 per cent of industrial energy requirements by the year 2000.

The generation by industries of their own electricity, rather than buying it from Ontario Hydro, is projected to almost triple over the projection period, reaching a level of nearly 10 million megawatt hours by the year 2000 in Cases 2 and 3.

Transportation Sector

The Transportation sector is the second largest sector of energy use. In 1975 oil accounted for over 99 per cent of the energy used in transportation.

As Figure 47 shows, consumption grew at an annual rate of 5.4 per cent between 1965 and 1975. The growth rate is expected to be more moderate from 1975 to the end of the century, with total consumption increasing at an annual rate of 2.3 per cent in Case 1 and at only 1.1 per cent in Case 3. This striking difference between historical and projected growth rates is due first to the expected lower increase in passenger

FIGURE 46: Industrial energy demand 1965-2000

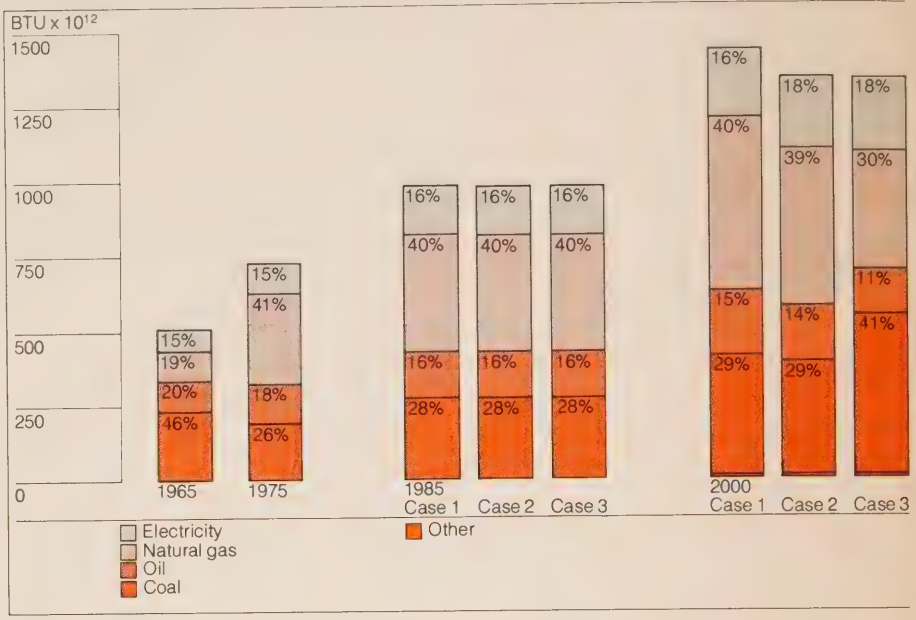
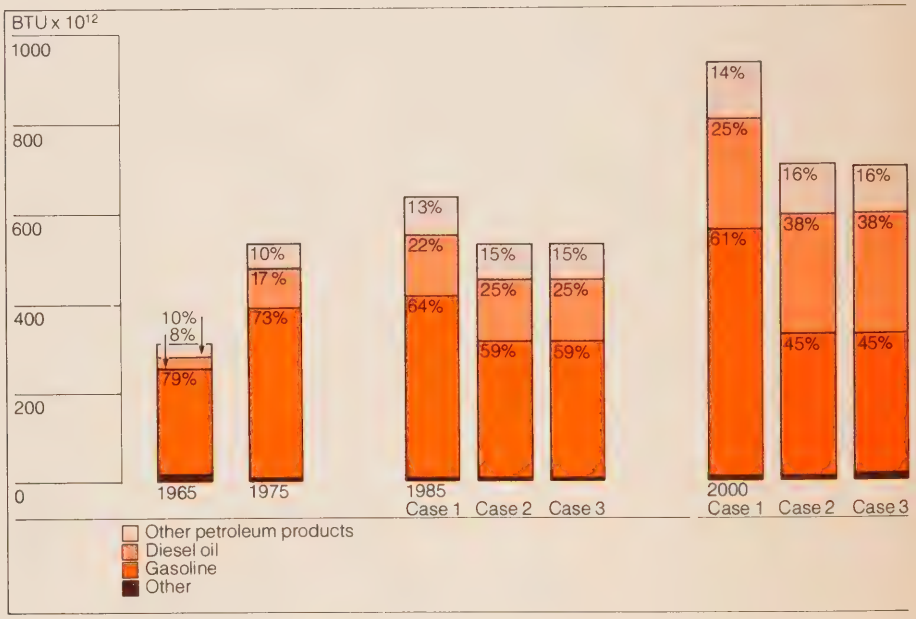


FIGURE 47: Transportation energy demand 1965-2000



vehicle registrations resulting from lower population growth. In fact, the share of auto travel in total transportation energy consumption will be reduced from its current level of 53 per cent to 41 per cent in Case 1 and, because of increased efficiency and dieselization, to 37 per cent in Cases 2 and 3. Secondly, the introduction of automobile fuel economy standards leads to a reduction in the average consumption of the new auto stock by 40 per cent by the mid-1980s. In addition, substantial efficiency improvements in air travel can be expected.

If transportation fuel requirements are divided between gasoline, diesel fuel, and other products, it is noticeable that the relative shares of gasoline and diesel fuel have changed. Diesel fuel is expected to continue increasing its share. In all three cases the increased share of diesel oil is a result of growth in truck transport in the freight sector and increasing use of diesel engines in both trucks and automobiles.

Some alternative fuels such as methanol, hydrogen, and electricity for car and rail transportation will require long lead-times and high capital costs to bring them to the Ontario market. They are thus not expected to make a significant contribution to the Ontario transportation energy requirements before the year 2000.

Residential Sector

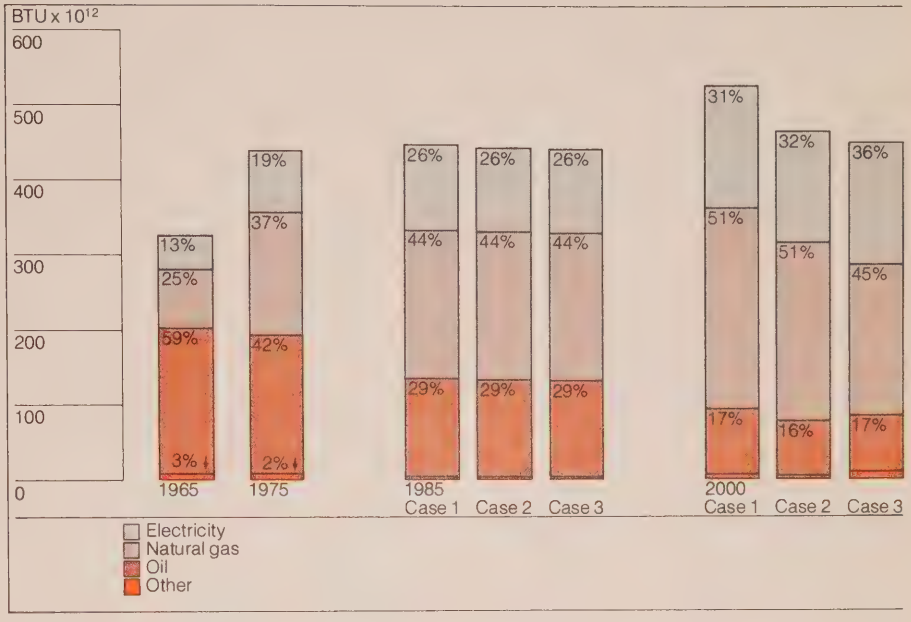
As Figure 48 shows, total energy consumption in the Residential sector rose by one-third between 1965 and 1975. Over the same period oil consumption rose only slightly in absolute terms but as a share declined from 59 to 42 per cent. Taking its place were natural gas and electricity. Coal, from 3 per cent of total consumption in 1965, virtually disappeared by 1975.

The projections suggest there will be very little growth in energy consumption until 1985, while a major upgrading of the current housing stock through home insulation is assumed to be taking place. After 1985, growth resumes but at lower than historical rates.

The growth rate in energy consumed over the whole outlook period is projected to be 0.7 per cent a year in Case 1 and 0.1 per cent in Case 3.

The additional conservation measures assumed in Cases 2 and 3 resulted by 2000 in reductions of 11 and 14 per cent respectively in over-all energy requirements compared to Case 1.

FIGURE 48: Residential energy demand 1965-2000



The historic trends observed in the fuel shares are projected to continue. Oil's share continues to decline to 29 per cent in 1985 and to 16 or 17 per cent in 2000. Some of oil's place is taken by gas, which grows to 44 per cent of total consumption in 1985 and to as much as one-half in 2000 in Case 1.

Electricity accounts for the rest, up to over one-quarter in 1985 and to over one-third in Case 3 in 2000.

The decline of oil's market share is accounted for by two factors: the reduced share of space heating in total Residential energy requirements and the substitution of natural gas and electricity. The thermal assistance of heat pumps and heat recovery systems is not projected to have a significant impact in this sector (because of their cost and maintenance requirements).

In Case 3, solar energy makes a modest contribution, about 1 per cent of the sector's requirements. This contribution requires installation of solar water heating systems in 280,000 homes and solar heating systems in about 36,000 homes, for a total of about thirty million square feet of collectors installed by the year 2000.

Long lead times and high initial capital costs will make negligible the contribution of district heating systems before the end of the century.

Commercial Sector

Total consumption in the Commercial sector rose by three-quarters between 1965 and 1975, as can be seen in Figure 49. The largest share in 1965 was oil at 44 per cent; this proportion had dropped dramatically to only 18 per cent in 1975, an absolute decline of about one-third.

Taking its place were gas, increasing its share from 25 to 47 per cent, and electricity, up similarly from 20 to 35 per cent. Once again coal, 11 per cent of the total in 1965, had dropped out of sight by 1975.

The projections show very small increases in total energy consumption.

Lower economic growth, falling school enrolments, and measures to limit the growth of the government sector, as well as strong conservation action, will lead to much lower growth in energy consumption than in the past. In Case 1 a growth rate of 1.3 per cent is projected for the period 1975 - 2000; for Cases 2 and 3 the projected growth is only 0.3 per cent.

Oil's share continues to dwindle, dropping to about one-tenth by 2000. Natural gas tends to hold its share at about two-fifths throughout. Electricity meanwhile continues to grow, surpassing gas by 1985 and reaching about one-half total consumption by 2000.

The switch from oil or natural gas to electricity in old buildings and the penetration of electricity in new buildings are expected to result from the choice of electrically driven heat pumps in those medium-to-large office and retail buildings for which such systems are economically feasible.

However, this increased electrical penetration and a higher saturation of air cooling units are largely offset by reduced requirements for the space conditioning resulting from the introduction of conservation measures.

In Case 3 solar energy, mainly in institutional buildings, makes a modest contribution of about 1 per cent to the sector's energy requirements in the year 2000, a result of the installation of about 25 million square feet of collectors. As in the Residential sector, it is assumed that district heating will make very little contribution to the over-all energy requirements over the next twenty years.

The energy supply for Ontario is, if anything, even harder to forecast than provincial demand. From Figure 45 it can be seen that in the year 2000 Ontario is expected to need about 290 million barrels of crude oil, 1.1 trillion cubic feet of natural gas, 26 million tonnes of coal, 2500 tonnes of uranium, and 40 million megawatt hours of hydro-electricity.

Except for uranium and water-power, Ontario relies on outside sources of supply for these fuels and is therefore dependent on the decisions of other governments, principally in Canada. While Ontario gets most of its petroleum requirements from elsewhere in Canada, some parts of Canada depend on supplies from unstable world oil markets. Therefore Ontario is not totally insulated from the inherent uncertainty of international events.

It might be asked whether the uncertainties of supply are large enough to make any forecast scarcely credible. The answer must be stated in terms of alternatives and probabilities. The previous three energy demand projections are based on various supply assumptions. Uncertainties in the supply outlook thus become uncertainties in the consumption forecast. Canada and therefore Ontario face two principal supply risks in particular: international crude oil supply disruptions by major producing countries and a failure to proceed with Canadian oil sands, heavy oil, and frontier development in a timely fashion. Barring these two occurrences, the consumption projections presented earlier provide a reasonable picture of the range of alternatives likely to prevail in Ontario. These consumption forecasts therefore do not assume the occurrence of a crude oil crisis.

The following is a brief summary of where Ontario's energy supply is likely to come from.

Oil

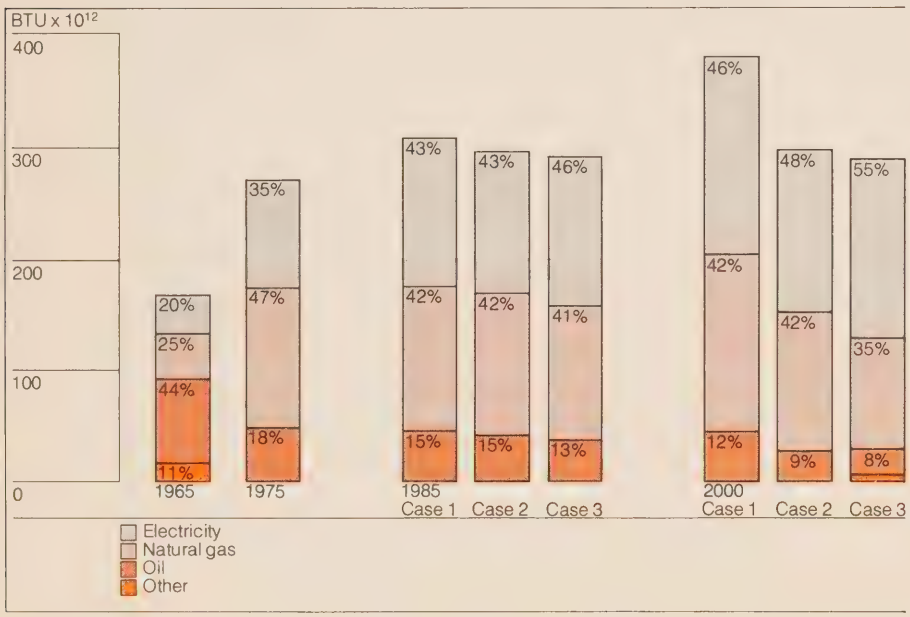
The projections show a declining role for oil in meeting Ontario's total energy requirements.

Total Ontario oil consumption in the year 2000 has been projected at 800,000 barrels a day in Case 1 and at 625,000 barrels a day in Case 3. In the latter nearly 70 per cent is used for non-energy petrochemicals or fuels for transportation. The scope for reducing Ontario's requirements further without major technological development is therefore limited without significant government intervention.

Using an estimate of Ontario's oil requirements similar to that in Case 1, the National Energy Board recently concluded (*Canadian Oil Supply and Requirements,* September 1978) that Canadian production would be sufficient in the area currently supplied with Canadian oil, which includes most of Ontario, until at least 1995, the final year of its forecast. However, the Board projected that more than half of Canadian oil production would be provided from the oil sands, whose development world oil prices are expected to be high enough to justify. However, the cost of these enormous industrial undertakings is such as to require a national commitment.

The National Energy Board's projections conclude that Canada will continue to depend on sources outside North America for part of its oil supply. As world oil begins to fall short of demand, a situation expected by most experts after the mid-1980s, world oil prices will escalate rapidly, and the economies of the world could be threatened by sudden supply interruptions. In view of these uncertainties, measures to reduce Canadian dependence on oil supplies from outside North America should be embarked upon without delay.

FIGURE 49: Commercial energy demand 1965-2000



Natural Gas

Ontario's natural gas use to the year 2000 is projected to show an average growth rate of up to 2 per cent a year. Growth in sales depends closely on consumers' seeing that future supplies are reasonably secure. What, then, are the prospects for future supplies?

Alberta provides 99 per cent of Ontario's natural gas. The bulk of this supply comes from Alberta under a removal permit issued to TransCanada PipeLines and due to expire in 1994. The Alberta Energy Resources Conservation Board (AERCB) controls the quantity of gas removed from the province in the interest of Alberta's own future consumers. The AERCB's view of the potential reserves is therefore decisive in the issuance of future removal permits. Using an estimate of the province's potential of 110 trillion cubic feet (Tcf). the AERCB concluded that Alberta would be able to meet demands from the rest of Canada as well as existing export commitments up to 1988.

In a more recent review of natural gas removal applications, the AERCB has increased its estimate of the province's potential to between 130 Tcf and 140 Tcf.

The National Energy Board concluded (Canadian Natural Gas Supply and Requirements, February 1979) that Canada can meet its own natural gas demand at least until the early 1990s.

Eventually the conventional gas supply from Alberta is expected to be replaced by supplies from the Mackenzie Delta, the Beaufort Sea, the arctic islands, and other frontier areas, as well as from the gasification of coal. Explorations in the Beaufort Sea, the arctic islands, and off the coast of Labrador, for instance, promise significant new gas sources, though a great deal more work is required before evaluations can be made. Moreover, there is little doubt that substantial non-conventional natural gas supplies exist, but it is also apparent that they will be more expensive and that much time will be required to find and develop them and transport them to market. Because of the lead times required to replace the cheaper conventional natural gas supplies, it is possible that some temporary market shortages could occur.

Over-all, though, a fairly secure supply of natural gas is expected beyond the year 2000, provided that transportation facilities connecting frontier reserves are put in place in a timely manner and the domestic market is not jeopardized by the export of too much of this non-renewable resource.

Coal

The demand for metallurgical coal in Ontario is expected to increase on average at roughly 3 per cent a year until 2000. The longer-term demand for thermal coal is less certain and could vary widely from year to year, but if future oil and gas supplies become uncertain the demand for thermal coal would likely increase more rapidly, averaging between 4 and 5 per cent a year to the end of the century. Total coal use in Ontario could nearly double, from around 16 million tonnes at present to over 30 million tonnes by the year 2000.

This level of coal consumption would be small compared with the vast reserves of coal that exist in conventional producing areas of western Canada. Research, development, and demonstration programs are being conducted in Canada and throughout the world on coal gasification, coal liquefaction, coal to make petrochemical products, and fluidized bed combustion. Progress is being made in all these areas.

However, the present high transportation cost of moving coal from western Canada to Ontario could limit access to the largest coal reserves.

Coal nevertheless represents a fairly secure long-term energy source in Canada, and future technological development could have a very significant impact on its rate of development.

Electricity

The long-term growth in electrical energy use is expected to be lower than in the past. The committed generation-expansion program and other projects under consideration, including medium-scale hydroelectrical schemes, development of lignite coal resources in northern Ontario, joint venture industrial cogeneration schemes, new coal and nuclear units, and the like, together ensure that Ontario consumers are unlikely to experience electricity shortages in the foreseeable future.

Two interrelated uncertainties of energy supply confront Ontario and Canada: crude oil supply disruptions by the major producing countries and failure to proceed with timely development of oil sands, heavy oil, and frontier energy sources. Solving the second uncertainty will in the longer run eliminate the first.

A greater degree of Canadian energy self-sufficiency seems possible and with it the prospect of freeing Ontario from many of the consequences of world energy disruptions. The province will of course never be totally isolated from world energy problems. But with self-sufficiency of oil assured and with serious conservation efforts, the worst effects of a world crude oil shortage can be alleviated.

Bibliography

Statistics Canada
Detailed energy supply and demand in Canada (57-207, 57-505)
Coal and coke statistics (45-002, 26-206)
Crude petroleum and natural gas production (26-006)
Electric power statistics (57-001, 57-202)
Refined petroleum products (45-004)

Canada. Department of Energy, Mines and Resources
Energy strategy for Canada (1976)
Energy conservation in Canada (1977)
Oil and natural gas resources of Canada 1976 (1977)
Oil sands and heavy oils: the prospects (1977)
1977 assessment of Canada's uranium supply and demand (1978)

National Energy Board
Canadian oil, supply and requirements (1978)
Canadian natural gas, supply and requirements (1979)

Canada. Central Mortgage and Housing Corporation
Canadian housing statistics (1977)
The conservation of energy in housing (1977)
Thermal efficiency in housing: potential for retrofit (1976)

Canada. Department of Transport
Energy issues and implications for the transportation sector (1977)
Energy research and development objectives and priorities (1977)
Freight forecasts – DERA (1978)
Potential energy conservation in urban commodity flow – University of Calgary (1978)

Canada. National Research Council Building Code
Energy conservation measures – NRC draft 1977-8

Canada. Department of Industry, Trade and Commerce
Second conference on industrial energy conservation – Ottawa 1976

Ontario. Ministry of Treasury and Economics
Ontario statistics 1978
Long-term economic outlook for Ontario (1976)
A long-term projection of Ontario's industrial development pattern (1976)
Long-term outlook for labour force growth: Canada and Ontario (1976)

Ontario. Ministry of Housing
Ontario housing requirements 1976-2001 – Peter Barnard Associates (1977)

Ontario. Ministry of Transportation and Communications
Industrial transportation requirements study (1978)
Transportation and communications technologies: a forecast 1977-1990 (1977)
Transportation energy conservation options (1975)

Ontario. Royal Commission on Electric Power Planning
Report on industrial by-product power – Leighton and Kidd (1977)
Projections for final demand for energy in Ontario to year 2000 – Haites and Sullivan (1978)
Solar heating: an estimate of market penetration – IBI Group (1977)
Energy conservation in Ontario buildings – Engineering Interface Ltd (1978)
Energy utilization and the role of electricity – Ontario Hydro (1976)

Ontario. Ministry of Energy
Ontario industrial energy demand study – Acres Consulting Services Ltd (1977)
Ontario residential and commercial energy demand study – Informetrica/Energy Research Group, Carleton University (1978)
Transportation energy demand analysis for Ontario – Canadian Resourcecon Ltd (1976)
Study of relative merits of bulk and individual metering for apartment buildings for Ontario (1977)
Reports of the advisory group on synthetic fuels (1978)
Hearst wood waste energy study (1979)
Turn on the sun (1978)
Perspectives on access to sunlight (1978)
Wind power report (1978)
Case studies of Ontario government buildings (1979)
Energy conservation in public buildings (1978)
Energy conservation opportunities for municipalities (1978)

Ontario Hydro
Statistical yearbook 1977
Energy application survey 1976 (1977)
Energy use in office buildings ECD 76-2 (1976)
Power market analysis, studies of energy use in Ontario industries (PMA 74-4, 74-8, 74-11, 75-3, 76-1, and 77-2)

Ontario commission on declining school enrolments in Ontario
Interim report (1978)

Ontario select committee on highway transportation of goods
A public policy direction for highway transportation of goods (1977)

United States
Residential and commercial energy use patterns 1970-1990. FEA. Final task force report. Project Independence (1974)
Project Independence: Energy conservation in the manufacturing sector 1954-1990 (1974)
Federal task force on motor vehicle goals beyond 1980. Volume 2 (1976)
Transportation energy conservation data book (1976)

Other sources
Battelle Columbus Laboratories. Energy use patterns in metallurgical and non-metallic mineral processing (1975)
Dow Chemical. Energy consumption: paper, stone/clay/glass/concrete and food
Gordian Associates, Inc. The potential for energy conservation in nine selected industries (1975)
Portland Cement Association. Energy conservation potential in the cement industry (1975)
Ralph Hedlin Associates. The past and potential markets for coal in the 'other' market (1978)
Thermo Electron Corporation. Potential for effective use of fuel in industry (1974)
Housing and Urban Development Association of Canada. A builders' guide to energy conservation (1975)
ASHRAE 90-75 standards: impacts of energy

First Printing July 1979

ISBN 0-7743-4026-6
(20m/July 1979)

Design: Keith Rushton and Associates